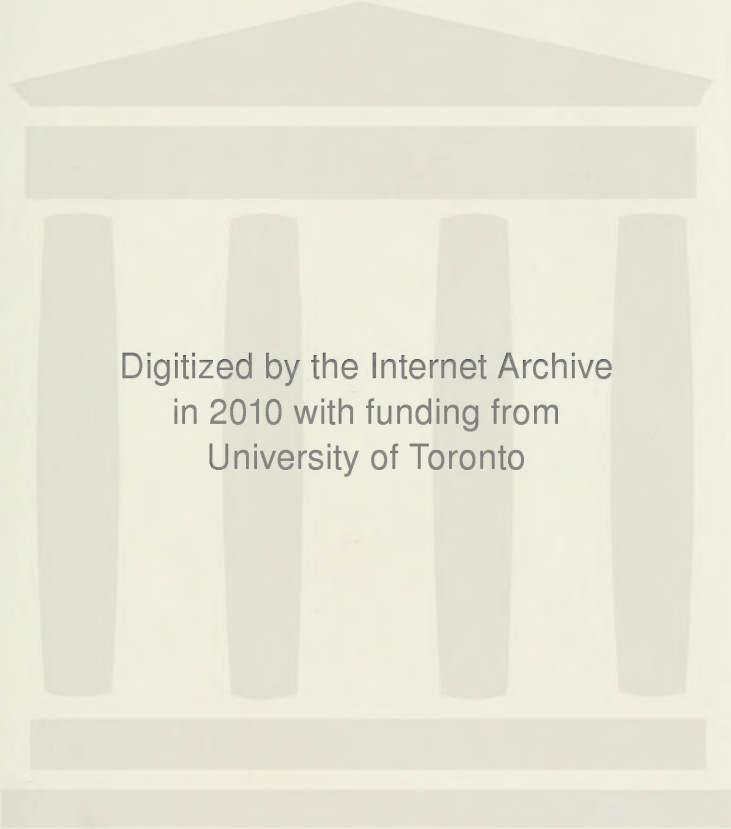






Digitized by the Internet Archive
in 2010 with funding from
University of Toronto

Enol.

Factory and Industrial Management.

(517)

THE
ENGINEERING MAGAZINE

AN INTERNATIONAL REVIEW

VOLUME XX

October, 1900, to March, 1901

NEW YORK

THE ENGINEERING MAGAZINE

1901

107112
71111

TA
/
F25
V.20

COPYRIGHT, 1900

By JOHN R. DUNLAP

INDEX TO VOLUME XX.

OCTOBER, 1900, TO MARCH, 1901.

The titles first appearing under each classification-head are those of leading articles in the Magazine. The titles in smaller type, which follow, indicate articles from other journals which have been editorially noticed in the "Review of the Engineering Press."

CIVIL ENGINEERING.

	PAGE.
THE REGULATION OF THE YELLOW RIVER IN CHINA <i>William Starling</i>	373
With 18 Illustrations.	
RUSSIA'S SYSTEMS OF INTERNAL WATERWAYS <i>Alexander Hume Ford</i>	829
With 18 Illustrations.	
ENGINEERING OPPORTUNITIES IN CENTRAL AND SOUTHWESTERN ASIA <i>H. H. Ford</i>	1068
With 14 Illustrations.	

REVIEWS.

American Society of Municipal Improvements.	119	Mississippi River, The Mouth of.	286
Alps as a Source of Power.	275	New York, Waste Water in.	122
Baltic-Caspian Canal.	112	Pittsburg, Water Filtration at.	953
Bilbao, Port of.	111	Port of Bilbao.	111
Breakwater, The Reaction.	454	Pumping Engine Economy.	281
Buildings, Height of.	117	Railway Development, The Influence of.	275
Caspian-Baltic Canal.	112	Reaction Breakwater, The.	454
Coaling of Warships at Sea.	792	Rebuilding the Kinzua Viaduct.	794
Coast Communication with the Great Lakes	455	Rhone, Hydraulic Power of.	272
Drinking Water, Pure.	781	River Regulation	114
Elastic Limit and Ultimate Strength.	786	Sewage, Treatment of London.	931
Engineering and Architecture.	1111	Siberian Railway, Progress of.	944
Filtration at Pittsburg, Water.	953	Simplon Tunnel, Progress of.	273
Gas Lighting, Intensified	783	Simplon Tunnel, Work on the.	788
Great Lakes, Coast Communication with	455	Strength, Elastic Limit and Ultimate.	786
Height of Buildings.	117	Testing Materials, Improvements.	789
Hydraulic Power of the Rhone.	272	Triangulation, Transcontinental.	947
Ice-Making, Distillation of Water for.	937	Ultimate Strength, Elastic Limit and.	786
Kinzua Viaduct, Rebuilding the.	794	Viaduct, Rebuilding the Kinzua.	794
London Sewage, Treatment of.	931	Waste Water in New York.	122
Mathematics for Engineers.	457	Water Filtration at Pittsburg.	953
Municipal Improvements, American-Society of.	119	Water for Ice-Making, Distillation of.	937
		Water-Jet in Engineering Construction.	796
		Water, Pure Drinking.	781
		Wind Pressure	113

INDEX to leading articles on Civil Engineering in the Engineering Press, including Bridges, Canals, Rivers and Harbours, Hydraulics, Irrigation, Sewerage, Streets and Pavements, Water Supply and Miscellany 128, 289, 462, 802, 958, 1118.
See also Index to Architectural Engineering in the Engineering Press, including Construction and Design, Heating and Ventilation, Plumbing and Gasfitting and Miscellany. 127, 289, 461, 801, 957, 1117.

ECONOMICS AND INDUSTRY.

	PAGE.
THE WORLD'S NEED OF COAL AND THE UNITED STATES' SUPPLIES <i>F. E. Saward</i>	I
NATIONAL IDEALS THE PRIME INFLUENCE IN IRON-TRADE DEVELOPMENT <i>H. J. Skelton</i>	9

ELECTRIC-POWER DISTRIBUTION IN GREAT BRITAIN	<i>W. H. Booth</i>	41
THE COMMERCIAL ORGANISATION OF THE MACHINE-SHOP	<i>Hugo Diemer</i>	73
V. Practical and Accurate Time- Keeping		
With 5 Forms.		
VI. The Figuring of Total Costs		229
THE LOADING AND TRANSPORT OF SEA-BORNE COAL	<i>F. Seaton Snowdon</i>	157
With 24 Illustrations.		
THE DEVELOPMENT OF ELECTRIC RAILWAYS IN ITALY	<i>Enrico Bignami</i>	173
With 17 Illustrations.		
PIECE-WORK AS AN AGENCY IN MACHINE- SHOP COST REDUCTION	<i>M. Cokely</i>	192
THE GENERAL PRINCIPLES OF SUCCESSFUL MINE MANAGEMENT	<i>A. G. Charleton</i>	235
THE LOCOMOTIVE EXHIBIT AT THE PARIS EX- POSITION	<i>Charles Rous-Marten</i>	247
With 9 Illustrations.		
THE INDUSTRIAL SIGNIFICANCE OF THE ANGLO-GERMAN ALLIANCE	<i>Editorial</i>	325
THE EXPENSE ACCOUNT OF THE MACHINE SHOP	<i>H. L. Arnold</i>	365
THE REGULATION OF THE YELLOW RIVER IN CHINA	<i>William Starling</i>	373
With 18 Illustrations.		
THE MEANING OF COMMERCIAL ORGANISA- TION	<i>A. Hamilton Church</i>	391
THE IRON ORES OF BRITISH COLUMBIA	<i>H. Mortimer Lamb</i>	399
With 4 Illustrations.		
CENTRAL STATION PRACTICE IN ENGLAND	<i>Frank C. Perkins</i>	408
With 14 Illustrations.		
LORD ARMSTRONG AND THE ELSWICK WORKS	<i>Benjamin Taylor</i>	491
With 9 Illustrations.		
THE HUGE ENTERPRISES BUILT UP BY AN- DREW CARNEGIE	<i>Charles M. Schwab</i>	505
With 12 Illustrations.		
THE FOUNDERS OF THE KRUPP ESTABLISH- MENTS	<i>E. Schrödter</i>	519
With 8 Illustrations.		
GEORGE WESTINGHOUSE—INVENTOR, ORGAN- ISER AND DIRECTOR	<i>Walter M. McFarland</i>	531
With 15 Illustrations.		
USES AND ABUSES OF ORGANISATION AMONG EMPLOYERS AND EMPLOYEES	<i>Sir Benjamin C. Browne</i>	553
I. What Employers May Prevent and Effect by United Action		
II. The Old Trade-Unionism <i>vs.</i> Wisely-Organised Labour	<i>G. N. Barnes</i>	560

INTENSIFIED PRODUCTION AND ITS INFLUENCE UPON THE WORKER	<i>Milton P. Higgins</i>	568
ALTRUISM AND SYMPATHY AS FACTORS IN WORKS ADMINISTRATION	<i>John H. Patterson</i>	577
With 65 Illustrations.		
THE RELATION OF THE STEAM ENGINE TO MODERN ECONOMIC PRODUCTION	<i>F. R. Hutton</i>	609
THE TAYLOR DIFFERENTIAL PIECE-RATE SYSTEM	<i>Sanford E. Thompson</i>	617
THE PREMIUM PLAN OF LABOUR REMUNERA- TION	<i>H. M. Norris</i>	631
A SURVEY OF MODERN FOUNDRY PRACTICE	<i>Percy Longmuir</i>	641
With 19 Illustrations.		
THE PRINCIPLES AND METHODS OF PRACTI- CALLY OPERATING THE MINE		
I. The Practical Management of Mining Operations	<i>John E. Hardman</i>	665
With 10 Illustrations.		
II. Office Organisation, Cost-Keep- ing, and Records of Work Done	<i>A. G. Charleton</i>	685
With 7 Tables.		
COST-KEEPING: A SUBJECT OF FUNDAMENTAL IMPORTANCE	<i>James Newton Gunn</i>	703
THE MECHANICAL AND COMMERCIAL LIMITS OF SPECIALISATION	<i>J. Slater Lewis</i>	709
SHOP ARRANGEMENT AS A FACTOR IN EFFI- CIENCY	<i>H. F. L. Orcutt</i>	717
THE RADICAL POLICY OF SCRAPPING COSTLY MACHINERY	<i>H. F. J. Porter</i>	741
With 3 Illustrations.		
THE DISCIPLINE AND CONTROL OF RAILWAY EMPLOYEES	<i>W. H. Canniff</i>	753
STRENGTH AND WEAKNESS OF THE COMBINA- TION OR TRUST IDEA		761
I. The Policy, Methods, and Aims of the Standard Oil Company	<i>John D. Rockefeller</i>	
II. Some Popular Delusions Con- cerning Trusts	<i>Andrew Carnegie</i>	
III. The Demoralising Influence of Speculative Promoters	<i>James G. Dill</i>	
IV. Imperative Need of Greater Pub- licity in Company Management	<i>The Late Lord Chief Jus- tice Russell</i>	
RUSSIA'S SYSTEM OF INTERNAL WATERWAYS With 18 Illustrations.	<i>Alexander Hume Ford</i>	829
INDUSTRIAL ASCENDENCY OF THE ANGLO- AMERICAN PEOPLES	<i>Caspar L. Redfield</i>	847
ORGANISATION OF THE FACTORY SALES DE- PARTMENT	<i>O. D. Hogue</i>	853
THE QUESTION OF COST OF HIGH-SPEED TRAINS	<i>Charles Rous-Marten</i>	885
With 3 Illustrations.		

GOLD MINING AND MILLING IN WESTERN AUSTRALIA	<i>A. G. Charleton</i>	
I. History, Position, and General Features of the Gold-Fields		897
With 7 Illustrations.		
THE APPLICATION OF PIECE WORK AND THE PREMIUM PLAN	<i>Sir Benj. C. Browne</i>	913
ARBITRATION OF LABOUR QUESTIONS NECESSARY TO INDUSTRIAL ASCENDENCY	<i>C. B. Going</i>	920
THE COMING INDUSTRIAL EMPIRE OF PUGET SOUND	<i>D. B. Bogle</i>	989
INFLUENCE OF THE EXPOSITION ON THE FRENCH IRON AND STEEL INDUSTRY	<i>Henri Guerin</i>	1043
With 1 Illustration.		
ENGINEERING OPPORTUNITIES IN CENTRAL AND SOUTHWESTERN ASIA	<i>H. H. Ford</i>	1068
With 14 Illustrations.		
THE RECKONING OF COSTS FOR ISOLATED ELECTRIC PLANTS	<i>P. R. Moses</i>	1083

REVIEWS.

Alps as a Source of Power.....	275	Great Lakes, Coast Communication with	455
Aluminum, The Progress of.....	1111	Hydraulic Power of the Rhone.....	272
American Coal in England.....	104	Iron and Steel Question.....	267
American Engines in England.....	120	Iron Industry in the Urals.....	271
American Railway Statistics.....	458	Iron, Manufacture of.....	936
American Society of Municipal Improvements.....	119	Judgment in Technical Matters.....	1108
Association Screw Gauge.....	266	London Sewage, Treatment of.....	931
Baltic-Caspian Canal.....	112	Machine Works, Reorganisation of.....	105
Barmen-Elberfeld Railway.....	448	Massena Power Plant.....	457
Bilbao, Port of.....	111	Mathematics for Engineers.....	457
Blast-Furnace Practice, American and British	268	Municipal Improvements, American Society of.....	119
British Navy, Engineering in.....	782	Navy, Engineering in the British.....	782
Caspian-Baltic Canal.....	112	Nineteenth Century, Engineering in.....	1095
Coal in England, American.....	104	New York, Waste Water in.....	122
Coal, The Burden of.....	263	Pig-Iron Production, American.....	283
Coal to Europe, Transport of American.....	270	Pittsburg, Water Filtration at.....	953
Coast Communication with the Great Lakes.....	455	Port of Bilbao.....	111
Corliss Engines at the Exposition.....	116	Power Generation, Cost of.....	264
Cost of Power Generation.....	264	Priggishness in Science.....	438
Drinking Water, Pure.....	781	Profession of Electrical Engineering.....	776
Education and Trade.....	938	Progress of Aluminum.....	1111
Education of Railroad Men.....	279	Railroad Men, The Education of.....	279
Education, Technical.....	1093	Railway Development, The Influence of.....	275
Elberfeld-Barmen Railway.....	448	Railway Statistics, American.....	458
Electrical Engineering, The Profession of	776	Reorganisation of Machine Works.....	105
Engineering in the British Navy.....	782	Rhone, Hydraulic Power of the.....	272
Engineering in the Nineteenth Century.....	1095	Science, Evolution of.....	1105
Engineering Work, Insularity in.....	440	Science, Priggishness in.....	438
Engineer, The Training of.....	435	Screw Gauge, Association.....	266
England, American Engines in.....	120	Sewage, Treatment of London	931
Evolution of Science.....	1105	Siberian Railway, Commercial Influence of.....	1103
Exhaustion of Nature's Stores.....	1109	Siberian Railway, Progress of the.....	944
Exposition, Corliss Engines at.....	116	Standardisation in Manufactures.....	441
Filtration at Pittsburg, Water.....	953	Steel Question, Iron and.....	267
Gas Lighting, Intensified.....	783	Trade, Education and.....	938
		Technical Education.....	1093
		Training of Engineers.....	435
		Transport of American Coal to Europe.....	270

Triangulation, Transcontinental.....	947	Water Filtration at Pittsburg.....	953
Urals, Iron Industry in.....	271	Water, Pure Drinking.....	781
Waste Water in New York.....	122		

INDEX to leading articles on Economics and Industry and Industrial Sociology in the Engineering Press, and Current Reviews, including Commerce and Trade, Currency and Finance, Government Control, Labour, etc., will be found under Miscellany in the various departments.

ELECTRICAL ENGINEERING.

	PAGE.
ELECTRIC-POWER DISTRIBUTION IN GREAT BRITAIN <i>W. H. Booth</i>	41
THE DEVELOPMENT OF ELECTRIC RAILWAYS IN ITALY <i>Enrico Bignami</i>	173
With 17 Illustrations.	
CENTRAL STATION PRACTICE IN ENGLAND <i>Frank C. Perkins</i>	408
With 14 Illustrations.	
GEORGE WESTINGHOUSE—INVENTOR, ORGAN- ISER AND DIRECTOR <i>Walter M. McFarland</i>	531
With 15 Illustrations.	
APPLICATIONS OF ELECTRICITY IN ENGINEER- ING WORKS <i>Louis Bell</i>	723
With 22 Illustrations.	
ELECTRIC POWER MACHINERY IN IRON AND STEEL WORKS <i>Sidney F. Walker</i>	858
With 17 Illustrations.	
THE RECKONING OF COSTS FOR ISOLATED ELECTRIC PLANTS <i>P. R. Moses</i>	1083

REVIEWS.

Alps as a Source of Power.....	275	Locomotives and Multiple Driving. Electric.....	932
Central Stations, Large Gas Engines for	934	Locomotives, Steam and Electric.....	778
Cost of Power Generation.....	264	Massena Power Plant.....	457
Distribution, Electrical Power.....	101	Measurement of Power, Electrical...	797
Electrical Equipment of Modern War- ships.....	930	Multiplex Space Telegraphy.....	1099
Electrical Measurement of Power.....	797	Multiple Driving, Electric Locomotives and.....	932
Electric Locomotives and Multiple Driving.....	932	Oscillations and Waves, Electric.....	1091
Electric Oscillations and Waves.....	1091	Power Distribution, Electric.....	1098
Electric Power Distribution.....	1098	Power, Electrical Measurement of.....	797
Electric Power in Workshops.....	951	Power Generation, Cost of.....	264
Electric Traction for Heavy Railway Service.....	1107	Power in Workshops, Electric.....	951
Electric Stimulus.....	264	Power Plant, St. Croix Hydraulic.....	954
Electricity in Warfare.....	1094	Power Plants, The Regulation of....	121
Engine and Generator Builders, Rela- tions Between.....	798	Profession of Electrical Engineering..	776
Engineering, The Profession of Electri- cal.....	776	Railway Service, Electric Traction for Heavy.....	1107
Gas as a Source of Motive Power. Lean.....	447	Rapid Telegraphy, Progress in.....	436
Gas Engines for Central Stations, Large.....	934	Regulation of Electric-Power Plants...	121
Generator Builders, Relations Between Engines and.....	798	Rhone, Hydraulic Power of.....	272
Hydraulic Power of the Rhone.....	272	Space Telegraphy, Multiplex.....	1099
Hydraulic Power Plant, St. Croix.....	954	St. Croix Hydraulic Power Plant.....	954
Incandescent Lamps, The Rating of...	280	Stimulus, Electric.....	264
		Warfare, Electricity in.....	1094
		Warships, Electrical Equipment of Modern.....	939
		Waves, Electric Oscillations and.....	1091
		Workshops, Electric Power in.....	951

INDEX to leading articles on Electrical Engineering in the Engineering Press, including Electro-Chemistry and Metallurgy, Lighting, Power, Telegraphy and Telephony, and Miscellany..... 784, 794, 467, 806, 963, 1123.

MARINE AND NAVAL ENGINEERING.

	PAGE.
THE LOADING AND CARRIAGE OF SEA-BORNE COAL <i>F. Seaton Snowdon</i>	157
With 24 Illustrations.	
THE APPLICATION OF WATER-TUBE STEAM GENERATORS FOR NAVAL SERVICE . . . <i>B. H. Thwaite</i>	
With 4 Illustrations.	
I. Their Comparative Suitability, Efficiency, and Convenience in War-Ships	199
II. Principal Classes and Representa- tive Types of Water-Tube Boilers	331
With 36 Illustrations.	
LORD ARMSTRONG AND THE ELSWICK WORKS <i>Benjamin Taylor</i>	491
With 9 Illustrations.	
EQUIPMENT AND METHODS OF THE INDIAN DOCKYARDS <i>A. C. Bowden</i>	1001
With 16 Illustrations.	

REVIEWS.

American Navy, Steam Engineering in.	451	Experimental Basin at Washington ..	795
Boilers in the British Navy.....	103	Fighting Ships, Machinery of.....	107
Boiler Tubes, Corrosion of.....	118	Fouling of Ships.....	102
British Navy, Boilers in.....	103	Machinery of Fighting Ships.....	107
British Navy, Engineering in.....	782	Navy, Engineering in British.....	782
Coaling of Warships at Sea.....	792	Ships, Fouling of.....	102
Coal to Europe, Transport of Ameri- can	270	Steam Engineering in the American Navy	451
Corrosion of Boiler Tubes.....	118	Submarine Boats.....	1098
Electrical Equipment of Modern War- ships	939	Torpedoes, Automobile.....	274
Electricity in Warfare.....	1094	Transport of American Coal to Europe.	270
Engineering in British Navy.....	782	Warfare, Electricity in.....	1094
		Warships, Electrical Equipment of...	939

INDEX to leading articles on Marine and Naval Engineering in the Engineering Press and Current Reviews,
including Boilers and Engines, Naval Affairs, and Miscellany.....140, 303, 474, 812, 970, 1130.

MECHANICAL ENGINEERING.

	PAGE.
NATIONAL IDEALS THE PRIME INFLUENCE IN IRON-TRADE DEVELOPMENT <i>H. J. Skelton</i>	9
THE USE OF WATER POWER BY DIRECT AIR COMPRESSION <i>Wm. O. Webber</i>	50
With 6 Illustrations.	
THE CENTRALISATION OF THE STEAM CON- DENSING PLANT <i>Harry G. V. Oldham</i>	
I. Important Recent Progress in In- creasing Power-House Econ- omy	56
With 15 Illustrations.	
II. Types of Cooling Towers, Evap- orating Condensers, and Auxili- aries	
With 19 Illustrations.	
THE COMMERCIAL ORGANISATION OF THE MACHINE-SHOP <i>Hugo Diemer</i>	73
V. Practical and Accurate Time- Keeping	
With 5 Forms.	

VI. The Figuring of Total Costs . . .	229
THOUSAND-MILE AUTOMOBILE TRIALS . . . <i>W. Worby Beaumont</i>	81
With 14 Illustrations.	
PIECE-WORK AS AN AGENCY IN MACHINE-SHOP COST REDUCTION <i>M. Cokely</i>	192
THE APPLICATION OF WATER-TUBE STEAM GENERATORS FOR NAVAL SERVICE . . . <i>B. H. Thwaite</i>	
I. Their Comparative Suitability, Efficiency, and Convenience in War-Ships	199
With 4 Illustrations.	
II. Principal Classes and Representative Types of Water-Tube Boilers	331
With 36 Illustrations.	
THE EXPENSE ACCOUNT OF THE MACHINE SHOP <i>H. L. Arnold</i>	365
THE MEANING OF COMMERCIAL ORGANISATION <i>A. Hamilton Church</i>	391
CENTRAL STATION PRACTICE IN ENGLAND . . . <i>Frank C. Perkins</i>	408
With 14 Illustrations.	
MOTIVE-POWER FROM HIGH-FURNACE GASES <i>Bryan Donkin</i>	422
With 6 Illustrations.	
LORD ARMSTRONG AND THE ELSWICK WORKS <i>Benjamin Taylor</i>	491
With 9 Illustrations.	
THE HUGE ENTERPRISES BUILT UP BY ANDREW CARNEGIE <i>Charles M. Schwab</i>	505
With 12 Illustrations.	
THE FOUNDERS OF THE KRUPP ESTABLISHMENTS <i>E. Schrödter</i>	519
With 8 Illustrations.	
GEORGE WESTINGHOUSE—INVENTOR, ORGANISER AND DIRECTOR <i>Walter M. McFarland</i>	531
With 15 Illustrations.	
GREAT WORKSHOPS OF THE WORLD	
A Series of Photographic Reproductions	547, 603, 736
With 38 Illustrations.	
USES AND ABUSES OF ORGANISATION AMONG EMPLOYERS AND EMPLOYEES <i>Sir Benjamin C. Browne</i>	553
I. What Employers May Prevent and Effect by United Action . . .	
II. The Old Trade-Unionism <i>vs.</i> Wisely-Organised Labour . . . <i>G. N. Barnes</i>	560
INTENSIFIED PRODUCTION AND ITS INFLUENCE UPON THE WORKER . . . <i>Milton P. Higgins</i>	568
ALTRUISM AND SYMPATHY AS FACTORS IN WORKS ADMINISTRATION <i>John H. Patterson</i>	577
With 65 Illustrations.	
THE RELATION OF THE STEAM ENGINE TO MODERN ECONOMIC PRODUCTION . . . <i>F. R. Hutton</i>	609

THE TAYLOR DIFFERENTIAL PIECE-RATE SYSTEM	<i>Sanford E. Thompson</i>	617
THE PREMIUM PLAN OF LABOUR REMUNERATION	<i>H. M. Norris</i>	631
A SURVEY OF MODERN FOUNDRY PRACTICE With 19 Illustrations.	<i>Percy Longmuir</i>	641
COST-KEEPING: A SUBJECT OF FUNDAMENTAL IMPORTANCE	<i>James Newton Gunn</i>	703
THE MECHANICAL AND COMMERCIAL LIMITS OF SPECIALISATION	<i>J. Slater Lewis</i>	709
SHOP ARRANGEMENT AS A FACTOR IN EFFICIENCY	<i>H. F. L. Orcutt</i>	717
APPLICATIONS OF ELECTRICITY IN ENGINEERING WORKS With 22 Illustrations.	<i>Louis Bell</i>	723
THE RADICAL POLICY OF SCRAPPING COSTLY MACHINERY With 3 Illustrations.	<i>H. F. J. Porter</i>	741
STRENGTH AND WEAKNESS OF THE COMBINATION OR TRUST IDEA		761
I. The Policy, Methods and Aims of the Standard Oil Company	<i>John D. Rockefeller</i>	
II. Some Popular Delusions Concerning Trusts	<i>Andrew Carnegie</i>	
III. The Demoralising Influence of Speculative Promoting	<i>James B. Dill</i>	
IV. Imperative Need of Greater Publicity in Company Management	<i>The Late Lord Chief Justice Russell</i>	
ORGANISATION OF THE FACTORY SALES DEPARTMENT	<i>O. D. Hogue</i>	853
ELECTRIC-POWER MACHINERY IN IRON AND STEEL WORKS With 17 Illustrations.	<i>Sydney F. Walker</i>	858
AUXILIARY STEAM AND WATER APPLIANCES FOR WATER-TUBE BOILERS With 16 Illustrations.	<i>B. H. Thwaite</i>	877
THE APPLICATION OF PIECE WORK AND THE PREMIUM PLAN	<i>Sir Benj. C. Browne</i>	913
ARBITRATION OF LABOUR QUESTIONS NECESSARY TO INDUSTRIAL ASCENDANCY	<i>C. B. Going</i>	920
INFLUENCE OF THE EXPOSITION ON THE FRENCH IRON AND STEEL INDUSTRY With 1 Illustration.	<i>Henri Guerin</i>	1043

REVIEWS.

Alps as a Source of Power.....	275	Association Screw-Gauge.....	266
American Engines in England.....	120	Banki Motor.....	115
American Navy, Steam Engineering in.	451	Balloons, Dirigible.....	278

Boiler Tubes, Corrosion of.....	118	Liquid Fuel.....	779
Boiler Shells, Strength of.....	784	Locomotives, Distribution of Steam in Compound.....	785
Blast-Furnace Practice, American and British.....	268	Locomotives, Steam and Electric.....	778
Boilers in British Navy.....	103	Lubricants, Internal Friction of.....	941
British Navy, Engineering in.....	782	Machine Works, Reorganisation of.....	105
Bronze, Influence of Heat on.....	1106	Machinery of Fighting Ships.....	107
Central Stations, Large Gas Engines for.....	934	Massena Power Plant.....	457
Coaling of Warships at Sea.....	792	Mathematics for Engineers.....	457
Coke-Oven Systems, Modern.....	445	Measurement of Power, Electrical.....	797
Compound Locomotive, Distribution of Steam in.....	785	Measurement of Steam.....	940
Compressed Air Traction in New York.....	949	Motor, Banki.....	115
Corliss Engines at the Exposition.....	116	Moulding by Machinery.....	282, 1113
Corrosion of Boiler Tubes.....	118	Navy, Engineering in British.....	782
Cost of Power Generation.....	264	Phase Theory of Iron and Steel.....	943
Cranes, Foundry Traveling.....	452	Pneumatic Appliances in the Foundry.....	948
Education, Technical.....	1093	Power, Electrical Measurement of.....	797
Elastic Limit and Ultimate Strength.....	786	Power Gas Development.....	787
Electric Power in Workshops.....	951	Power Gas Generation.....	443
Electrical Measurement of Power.....	797	Power Generation, Cost of.....	204
Engine and Generator Builders, Relations Between.....	798	Power in Workshops, Electric.....	951
Engineering in British Navy.....	782	Power Plant, St. Croix Hydraulic.....	954
Engineering Work, Insularity in.....	440	Pumping Engine Economy.....	281
Engineers, The Training of.....	435	Reorganisation of Machine Works.....	105
Engines in England, American.....	120	Rhone, Hydraulic Power of.....	272
Exposition, Corliss Engines at.....	116	Rolling Mills, Modern.....	442
Fighting Ships, Machinery of.....	107	St. Croix Hydraulic Power Plant.....	954
Foundry, Pneumatic Appliances in the.....	948	Screw Gauge, Association.....	266
Friction of Lubricants, Internal.....	941	Standardisation in Manufactures.....	441
Fuel, Gaseous.....	106	Steam Engines, Regulation of.....	1102
Fuel, Liquid.....	779	Steam Engineering in the American Navy.....	451
Furnace Gases, Heat and Power from.....	453	Steam Indicators, Reliability of.....	277
Gas as a Source of Motive Power, Lean.....	447	Steam, Measurement of.....	940
Gas Development, Power.....	787	Steam Turbine.....	942
Gas Engines for Central Stations, Large.....	934	Steam Turbine, Development of the.....	791
Gaseous Fuel.....	106	Steam Turbine in America, The Parsons.....	950
Generator Builders, Relations Between Engine and.....	798	Steel, Phase Theory of Iron and.....	943
Heat, Influence of, on Bronze.....	1106	Steel Question, Iron and.....	267
Heat, Transmission of, Through Metals.....	1101	Strength, Elastic Limit and Ultimate.....	786
High Temperature.....	437	Strength of Boiler Shells.....	784
Hydraulic Power of the Rhone.....	272	Technical Education.....	1093
Hydraulic Power Plant, St. Croix.....	954	Testing Materials, Improvements in.....	789
Ice-Making, Distillation of Water for.....	937	Torpedoes, Automobile.....	274
Induction Jets, A Study of.....	444	Traction in New York, Compressed Air.....	949
Iron and Steel, Phase Theory of.....	943	Training of Engineers.....	435
Iron and Steel Question.....	267	Traveling Cranes, Foundry.....	452
Iron, Manufacture of.....	936	Ultimate Strength, Elastic Limit and.....	786
		Water for Ice-Making, Distillation of.....	937
		Wind Pressure.....	113
		Workshops, Electric Power in.....	951

INDEX to leading articles on Mechanical Engineering in the Engineering Press, including Boilers, Furnaces and Piping, Compressed Air, Engines and Motors, Gas Engineering, Power and Transmission, Shop and Foundry, and Miscellany.....138, 141, 302, 305, 472, 476, 810, 814, 969, 971, 1129, 1132.

MINING AND METALLURGY.

THE WORLD'S NEED OF COAL AND THE UNITED STATES' SUPPLIES	<i>F. E. Saward</i>	I
THE CONNELLSVILLE COKE REGION	<i>F. C. Keighley</i>	17
With 29 Illustrations.		

THE GENERAL PRINCIPLES OF SUCCESSFUL MINE MANAGEMENT	<i>A. G. Charleton</i>	235
THE IRON ORES OF BRITISH COLUMBIA	<i>H. Mortimer Lamb</i>	399
With 4 Illustrations.		
THE PRINCIPLES AND METHODS OF PRACTI- CALLY OPERATING THE MINE		
I. The Practical Management of Mining Operations	<i>John E. Hardman</i>	655
With 10 Illustrations.		
II. Office Organisation, Cost-Keeping, and Records of Work Done	<i>A. G. Charleton</i>	685
With 7 Tables.		
GOLD MINING AND MILLING IN WESTERN AUSTRALIA	<i>A. G. Charleton</i>	
I. History, Position, and General Fea- tures of the Gold-Fields		897
With 7 Illustrations.		
II. General Geology of the Field, and the Dry-Blowing Process		1023
With 15 Illustrations.		

REVIEWS.

Aluminum, The Progress of.....	1097	Iron, Manufacture of.....	936
American Coal in England.....	104	Machinery, Coal Cutting by.....	1097
Blast-Furnace Practice, American and British	268	Petroleum Fuel in Metallurgy.....	110
Coal Cutting by Machinery.....	1097	Phase Theory of Iron and Steel.....	943
Coal in England, American.....	104	Pig-Iron Production, American.....	283
Coal, The Burden of.....	263	Progress of Aluminum.....	1111
Coal to Europe, Transport of American	270	Pumping Engine Economy.....	281
Coke-Oven Systems, Modern.....	445	Rescue Apparatus in Mining.....	450
Fuel in Metallurgy, Petroleum.....	110	Steel, Phase Theory of Iron and.....	943
Iron and Steel, Phase Theory of.....	943	Steel Question, Iron and.....	267
Iron and Steel Question.....	267	Transport of American Coal to Europe.	270
Iron Industry in the Urals.....	271	Urals, Iron Industry in.....	271

INDEX to leading articles on Mining and Metallurgy in the Engineering Press, including Coal and Coke, Copper, Gold and Silver, Iron and Steel, Mining, and Miscellany...146, 311, 480, 820, 977, 1138.

RAILWAY AFFAIRS.

THE LOCOMOTIVE EXHIBIT AT THE PARIS EX- POSITION	<i>Charles Rous-Marten</i>	247
With 9 Illustrations.		
THE DISCIPLINE AND CONTROL OF RAILWAY EMPLOYEES	<i>W. H. Canniff</i>	753
THE QUESTION OF COST OF HIGH-SPEED TRAINS	<i>Charles Rous-Marten</i>	885
With 3 Illustrations.		
ACTUAL WORKING OF AMERICAN LOCOMO- TIVES ON BRITISH RAILWAYS	<i>Charles Rous-Marten</i>	1055
With 10 Illustrations.		

REVIEWS.

American Railway Statistics.....	458	Locomotives, Efficiency of Express....	446
Barmen-Elberfeld Railway.....	448	Multiple Driving, Electric Locomotives	
Capacity of Railway Waggon.....	775	and	932
Compound Locomotives, Distribution of		Permanent Way Construction.....	123
Steam in.....	785	Railroad Men, The Education of.....	279
Construction, American Permanent		Railway Development, The Influence of	275
Way	123	Rebuilding the Kinzua Viaduct.....	794
Education of Railroad Men.....	279	Siberian Railway, Commercial In-	
Elberfeld-Barmen Railway.....	448	fluence of.....	1103
Electric Locomotives and Multiple		Siberian Railway, Progress of.....	944
Driving	932	Simplon Tunnel, Progress of.....	273
Express Locomotives, Efficiency of....	446	Simplon Tunnel, Work on the.....	788
Kinzua Viaduct, Rebuilding the.....	794	Speeds, Railway.....	439
Locomotives and Multiple Driving,		Statistics, American Railway.....	458
Electric	932	Viaduct, Rebuilding the Kinzua.....	794
Locomotives, Distribution of Steam in.	785	Waggon, Capacity of Railway.....	775

INDEX to leading articles on Railway Affairs in the Engineering Press, including Conducting Transportation, Financial, Legal, Motive Power and Equipment, New Projects, Permanent Way and Fixtures, Traffic and Miscellany.....151, 318, 485, 824, 982, 1143.

STREET AND ELECTRIC TRAMWAYS.

ELECTRIC-POWER DISTRIBUTION IN GREAT	
BRITAIN	<i>W. H. Booth</i> 41
THE DEVELOPMENT OF ELECTRIC RAILWAYS	
IN ITALY	<i>Enrico Bignami</i> 173
With 17 Illustrations.	

PAGE.

REVIEWS.

Compressed Air Traction in New York. 949	Multiple Driving, Electric Locomotives
Electric Locomotives and Multiple	and
Driving	932
Electric Traction for Heavy Railway	New York, Compressed Air Traction in 949
Service	Niagara Gorge Railway..... 284
Locomotives and Multiple Driving.	Paris Metropolitan Railway..... 109
Electric	Railway Service, Electric Traction for
Locomotives, Steam and Electric..... 778	Heavy
Manhattan Railway, Electrical Equip-	Traction in New York, Compressed
ment of.....1112	Air
	949

INDEX to leading articles on Street and Electric Tramways in the Engineering Press.....154, 322, 487, 827, 985, 1146.

EDITORIAL COMMENT.....99, 261, 433, 773, 927, 1089.

REVIEW OF THE ENGINEERING PRESS.

The British Press.....	101, 263, 435, 775, 931, 1091.
The Continental Press.....	109, 271, 443, 783, 939, 1099.
The American Press.....	117, 279, 451, 791, 947, 1107.

REVIEWS OF BOOKS.....988.



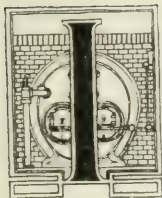
VOL. XX.

OCTOBER, 1900.

No. 1.

THE WORLD'S NEED OF COAL AND THE UNITED STATES' SUPPLIES.

By F. E. Saward. With Editorial Preface.



It is about thirty-five years since Professor Jevons predicted that, by the end of the century, England's commercial and industrial supremacy would be checked by inability to supply the ever-growing demand for fuel. The coal which gave her economic dominion—which, more than iron, was the basis of her material power—was even then evidently exhaustible. With its disappearance, apparently, her wealth and power would decline.

Trade expansion, spreading further and faster than seemed possible to the most sanguine a third of a century ago, has hastened the condition upon which Professor Jevons based his sinister prophecy. But in the meantime other factors—material, economic, and political—have entirely changed the problem. New countries have opened up not only new markets for consumption, but new sources of supply; improved transport, particularly by sea, has brought far-off shores practically nearer than the distant portions of our own land; above all, a broadened understanding of national and international relations has drawn the whole world closer and is ever enforcing the concept that the great storehouse of the world is a common one—that the funds of material, of energy, even of human skill and handicraft, are in reality and inevitably a joint possession, which it is the duty and destiny of mankind to utilise and to distribute to the uttermost for the good of

Copyright, 1900, by John R. Dunlap.

all. The new world, which supplied to the overburdened old world first room and opportunity to labour, then bread and clothing, now opens to the underfed furnaces, mills, and workshops of Europe almost limitless stores of the coal and iron which are the prime material necessities of modern life. These will prove as life-giving and as little to be considered menaces to England's prosperity as were the wheat of the prairies or the cotton of the southern States.

For England, who ever has been keen in discerning true commercial wisdom, prompt in acting upon it, and steadfast in holding to it, will seize upon the advantages of this development as she has upon events in the past, looking beyond the temporary and the superficial to the lasting and substantial interests of the manufactures and the commerce which have made her great. Anything that promotes those manufactures by cheapening them she will welcome and turn to advantage, shutting herself out from no benefits by self-made barriers of "protection" which cut off the inflow of wealth-making materials and the outflow of wealth-bringing products. With her far-seeing, strongly-founded system of free trade, she gathers to her open doors the best that the world can bring, sure of the soundness of a prosperity which is based, not on any artificial and shifting foundation of tariff legislation, but on buying where goods are best and cheapest, and so having the cheapest and best to sell wherever goods can be sold.

This is the true aspect of the movement toward "bringing coals to Newcastle," or to Cardiff. It is not an inroad on the British coal producer: ample home markets are his beyond possibility of loss. A portion of the burden of export demand, which is so seriously hampering the vitally-important home industries, may be assumed by the United States, with most beneficial results to England at large. Undue prices, checking prosperity and ultimately reacting to the disadvantage of the coal trade itself, will find their level. But if American coals can be landed in European ports at reasonable prices, it means simply that the thousands of factories, forges, workshops, and ship-yards, which are the framework of Britain's power, are assured against stoppage or decline. If America can feed Europe with coal and iron as she has fed her with wheat, the continents are entering on an era of surer prosperity, of greater mutual gain, of closer unity than any heretofore existing. Isolation within national boundaries belongs to a school of political economy which, happily, is dying. The country which gives the freest entry to the desirable products—material or intellectual—of other lands, to supplement its own store and liberate its own effort, is first in the progress toward wisdom, riches and power.—THE EDITORS.

COAL is heavy, both specifically and in its aggregate annual tonnage. It is by long odds the greatest item of the freight traffic on American railroads, constituting one-fourth of the total tonnage, and if we omit the duplication of tonnage resulting from the transportation of one shipment over two or more lines of railway it will be found that coal constitutes one-third of all the traffic moved in the United States. And although all indications now point to the fact that American progress towards the achievement of a great international coal trade will be steady and continuous, yet at the same time those who are concerned in the industrial progress of the United States need not fear that the exportation of coal will result in a diminished supply at home and increased prices for the fuel needed by manufacturers. Taking up the coal fields of the United States, as a whole, that is to say, the bituminous coal fields, with which alone exporters are concerned, it will be found that from the Atlantic to the Mississippi the country is well supplied, and though the quality gradually deteriorates as one progresses from east to west it so happens that each section is, or can be, supplied with suitable coal from its home fields.

In spite of continued effort to increase the efficiency of engines and boilers, the progress of invention is such that coal is becoming each year a more and more important article of commerce. So short a time ago, viewing the history of the world, as 1831, the annual coal production of Great Britain was 24,000,000 tons; for the year 1901 the coal production will probably be 240,000,000 tons, an increase of 1,000 per cent. In 1831 the population of Great Britain was 24,000,000, and the next census, 1901, will probably show about 40,000,000 in that country, an increase of 66 $\frac{2}{3}$ per cent. in 70 years. Therefore the production of coal has increased from one ton per capita to six tons, and the rate of increase has been 15 times as great as the rate of increase in population. The earliest statistics of coal production in the United States are very incomplete—in fact, prior to 1860 the output can only be guessed at; but such figures as are available show that in the United States, as in Europe, the increase in the use of coal has been phenomenal. In 1840 the production of bituminous coal in the United States was between 1,000,000 and 2,000,000 tons, and the production of anthracite was 1,000,000 tons—say a total of 2,500,000 tons. At that time the population of the country was 17,000,000, so that there was probably less than one-sixth of a ton used per capita.

Compare that with the present tonnage of 220,000,000 and a population of approximately 75,000,000, and it will be seen that America

is now using per capita eighteen times as much coal as she did sixty years ago. In fact, since 1890 the per capita increase has been 50 per cent. In that year and for some time prior thereto the coal requirements of the average community could be stated at two tons per person, but now three tons is the average for the country at large, and in all large places except the southern cities the average is above that.

First and foremost of the factors leading to this great increase in coal requirement has been the growth in the railway mileage at home and abroad. Such progress has now been made in the building of large locomotives that, counting in all the engines laid up for repairs, those temporarily in the shops, those in switching service and similar light duty, and those regularly employed on the road, it is found that some 1,600 tons of coal per annum are required for each locomotive in a company's service, on the presumption that the coal furnished is of good quality, and that the number of engines owned is great enough to make an average practicable. No more than ten years ago the average coal requirements of a locomotive did not exceed 1,000 tons a year. As there are now 40,000 locomotives in the United States and Canada* it will be seen that at least 64,000,000 tons of coal are annually required in this line of business, with the chances greatly in favor of a tonnage exceeding that amount. In fact, it has been claimed that one-half of the bituminous product of the United States (say 90,000,000 tons) is used by railways and steam vessels.

It is plain to all who give the matter more than passing interest that coal has come to the front, that it is in great demand the world over and that the United States is, at present, the coal cellar of the world. That it will become the coal *seller* of the world at an early date is a matter capable of mathematical demonstration.

Coal has always been high-priced in England. With the great prestige in manufacturing that the British people had for two generations in this century their manufacturers were ready and willing to pay high prices for their fuel. High prices were charged, and even though the business was conducted in a most crude and costly way, great fortunes were made by the coal proprietors of England, Scotland, and Wales. Properly conducted, the operations should have been comparatively economical, for the coal could be easily obtained; but now, after the lapse of a century of active mining, hundreds of millions of tons† have been extracted from the limited areas of Great Britain, and

* The large Canadian lines buy in the United States.

† It has been calculated that from the year 1600 to date 9,100,000,000 gross tons of coal or 10,101,000,000 net tons of coal have been produced in Great Britain.

it has come to such a pass that the high prices hitherto prevailing are absolutely required to meet the expenses of production and transportation, for now it is necessary to go deeper into the ground for the coal. Thinner seams have to be worked, the more attractive deposits having been exhausted. All the entries now are long, comparatively few new mines having been opened in Great Britain in the last ten years.

A moment's thought will make it plain that underground haulage and hoisting are enormously expensive methods of transportation, and that a certainty that these factors will increase in importance every day, as the coal industry grows older, makes it plain that the United States' coal fields, almost untouched as many of them are, grow steadily in advantage as regards the supply of the world. Generally speaking, there is not a coal mine in the seaboard bituminous regions from which coal has to be hoisted. It can in every case be drawn out in cars, sometimes up a grade, it is true, but quite as often the cars run down grade. Then, too, the American mines are generally new. All devices are contrived with the view of handling a large tonnage as economically as possible, and the present shipper of bituminous coal is not hampered by arrangements made years ago when trade requirements were less important. Very notable, too, have been the arrangements made by the railway companies for the transportation of coal. The tendency a few years ago toward lower prices caused the companies to scrutinize the matter of coal transportation with the utmost care, and the result is seen to-day in the almost scientific arrangements which have been made. The roads leading into the coal regions are solid and substantial, with grades and curves modified as far as the formation of the country will permit, and over them are operated trains of fifty 50-ton cars, drawn by huge slow-steaming locomotives. Owing to the allowance for extra weight generally permitted, the cars are often loaded to nearly 10 per cent. more than their marked capacity, making a consignment of 2,700 tons moved to market at one trip. The growth of the American coal trade will call for many additional branch lines into virgin territory, but the main lines of the coal-carrying roads are in excellent shape to carry an enormously increased tonnage. Probably with the addition of side-tracks to permit of the passing of passenger trains, the Norfolk & Western, the Chesapeake & Ohio, the Baltimore & Ohio, and the Pennsylvania could carry from 33 to 50 per cent. more coal than they are carrying to-day.

Another factor, little heard of but steadily operating towards increased production of coal, is the mining or coal-cutting machine. Tending as it does to displace manual labor to a great extent, the oper-

ators have usually hesitated to introduce it while their men were working satisfactorily, but when trouble has ensued and the men have held out stubbornly the introduction of mining machines has been one of the first incidents of resumption. By the use of mining machines it is possible to get out the coal with less breakage than results from ordinary hand mining and this is an important factor to those concerned in the export trade, for European consumers demand a lumpy coal.

For this reason, too, the coaling docks at which vessels are to be loaded for the export trade must also be built with closer regard to the prevention of breakage than is often the case at the present wharves. Small coal will burn as well as large, but as the European trade demands large coal they might as well have it, say the producers, as it can be furnished by the exercise of some little care and attention.

Having seen that there is an abundance of coal in the United States and that the facilities for transporting it to tide already exist, we find at present but limited facilities for ocean transportation. At this time, when the requirements of the United States government for transports to the East Indies and the West Indies have retired many American vessels from commercial pursuits, and when the great requirements of the British government for transportation to South Africa have taken 3,000,000 tons of vessel tonnage from the market, and general business activity has made miscellaneous freight plentiful for all vessels, it must be confessed that the average coal man, the owner of a few comparatively small mines, is at a decided disadvantage in regard to supplying the great export demand; but in so far as the large producing companies are concerned the question is by no means serious. Having ample resources, and operating in harmony with railway lines, with influential friends commanding ample capital, they will face the proposition as the Standard Oil Company took up the matter of exporting oil—not bidding against other shippers for the privilege of sending their merchandise in such steamers as might be at their disposal from time to time, but boldly starting in and building, without regard to subsidy or other political reasons, vessels designed expressly for coal-carrying, and for that purpose alone, though, to be sure, not unfitted for returning with any bulk freight offered.

It has been ascertained by interviews with thoroughly well-posted gentlemen in the ship-building and shipping business that a vessel having a cargo capacity of 7,000 tons would be best suited for this line of business, and that a speed of 10 knots is the most economical for such a vessel; faster time means more coal burned and slower time means fewer trips per year, so that 10 knots, which in practice will

allow for one round trip across the Atlantic and back each month, is found to be the most desirable speed.

It has been calculated by a careful compilation of figures that the cost of operating a 7,000-ton steamer to such an accessible port as Gibraltar, calculating the length of the voyage and time of unloading as 15 days, is as follows: Insurance, \$875; interest on cost, \$750; depreciation, \$625; crew, \$580; provisions, \$108; port charges, \$184; pilotage, \$330; fuel, \$2,025 (this allows full selling price for company's coal used for steam); with \$100 for incidentals, we have a total of \$5,637, making a cost of but 80.4 cents per ton for the actual transportation of the coal. Upon this basis the American product could be put in foreign markets at rates that would make competition simply impossible. Coal could be placed at Cardiff, the greatest coal-shipping port in the world, for \$3 less than the present wholesale selling price at that place, even supposing that the vessel was destined to return empty and the producer doubled the above-mentioned freight.

Yet that is an extreme instance. It is not probable that an American producer would offer the coal at such a close margin, but he would seek to compensate himself for his expenditure incurred in the development of foreign trade by adding a dollar or two per ton to the cost price abroad, as determined by cost, insurance, and freight. Even on this basis, which gives him a \$14,000 margin on a single cargo, there is \$1 in favor of the United States seller at Cardiff and nearly as much at every other port in the northern portion of the eastern continent; and when it comes to supplying the trade of South Africa and South America, both important, there is also some 2,000 miles of sea travel.

Unfortunately, there are but few shipyards in the United States capable of building 7,000-ton vessels. The reduction in the price of iron and steel during the present year, the improvement of facilities to meet the home demand, and the undiminished strength of the foreign demand, all combine to strengthen the interest of American producers in the export trade. Undoubtedly the building of steam colliers will soon commence at all the shipyards capable of such work.

Studying out the capabilities of American ship-building plants we can estimate the growth of coal shipments from the United States. It would be thought that ship-building was flourishing indeed if, beginning with January 1st, 1901, a 7,000-ton collier should be launched every fortnight. That would mean 26 such boats in a year, or say 100 in four years. The United States would have an annual shipping capacity of say $100 \times 7,000 \times 12 = 8,400,000$, and it would not be at all surprising if the foreign trade of the United States equaled that

amount in the year 1905. In addition thereto American bunker trade will grow steadily in importance. The time is not long past when British vessels trading in American ports brought over enough coal to meet partially their requirements for the home voyage. Recently this practice has been reversed, and some steamers have even taken coal enough in America to carry them to England and back. The United States now supply 6,000,000 tons of coal to foreign steamers each year. It would not be surprising to see these figures doubled in five years.

In arriving at the above calculation we disregard shipments in tramp vessels, for some of the 7,000-ton boats would go on long voyages and would not be able to return in a month's time, and so the shipments in ordinary steamers would just about keep up the average. The building up of this great export trade has something more than an interest for the coal trade; it means the elimination of a troublesome surplus from the soft-coal markets of the United States, and prosperity and good wages throughout the mining regions. The million men and boys employed therein, or connected with local industries, under the auspices of good times, would buy so much more freely than at present as to have a decided influence upon the general business of the country. The railroads would be greatly benefited by the increased earnings. Three thousand or more seafaring men would find continuous employment on the coal-carrying vessels, and shipyards and builders of marine engines would feel the impetus of the great addition to the American merchant marine.

Nor will the benefit stop with the advantages derived from the mining and shipping of coal. Cheap fuel going abroad to countries now devoid of that blessing will lead to their development, American colliers will bring back the merchandise of those countries, and as developments progress markets will be found for manufactures of every description and from all countries. Now that the English have an undisguised preference for retaining their fuel supplies at home, it would seem to be in harmony with Anglo-Saxon brotherhood for the United States to succeed to a share in the export coal business. When it does come to pass that the United States supply the foreign nations with as much coal as England now supplies to them and to foreign-bound ships, some 55,000,000 tons in all, and gain such a return trade as England has gained, they will indeed be far advanced towards permanent prosperity, and will need to have no remedies proposed by political speech-makers. On a solid, substantial basis of great lumps of coal will rest one of the nation's most important industries.

NATIONAL IDEALS THE PRIME INFLUENCE IN IRON-TRADE DEVELOPMENT.

By H. J. Skelton.

IN the early seventies, when I was a youth in the drawing office of a large steel and iron works in Sheffield, the idea prevalent amongst young men in steel or engineering works, or such of them as had ambition or a consciousness of ability beyond the average, was that if there were not sufficient opportunity of fairly rapid and well remunerated advancement at home there was at least an opportunity outside old England in the great Republic of the west. From time to time one heard of migration of eager, spirited men, to the United States of America, where there seemed to be openings with an ample scope for mental and physical activity for all who cared to venture. It is somewhat piquant to reflect that much of the remarkable development that has taken place in American iron and steel industries may be due to the brains of those young men who could not find sufficiently good scope to satisfy their ideas, or sufficiently good pay to satisfy their ambitions, in Great Britain.

There are not a few people who think that the development of American iron and steel industries will not only shake the supremacy of Great Britain at home and in the markets of the world, but will change the entire European situation. This involves an enquiry as to whether Great Britain has lost ground, and if so, some enquiry why she has done so, and a consideration of the probable consequences of the new competition.

There is little doubt that Great Britain has lost ground. The progress and development of a nation depend in some considerable part upon the ideals or state of social opinion that obtain in the nation, quite as much as upon the possession of suitable raw materials of manufacture, the skill and capacity of its workers, and an advantageous geographical position. Economists on the continent of Europe have not hesitated to assert that a considerable portion of British

Mr. Skelton's article is remarkable for its appreciation and expression of the deep-lying relations of engineering work with the nation's political and social order. Engineers are sometimes indifferent to political and economic matters, but it is on such foundations that the whole fabric of their work rests. The sources of national tendency in constructive or productive enterprise are to be found, side by side with those of national character, in well-rooted ideals of law, education, and custom. Mr. Skelton, in reviewing competitive conditions in the most important branch of the engineering trade, goes direct to these fundamentals.—
THE EDITORS.

supremacy in manufactures is due to the state of unhindered development that was possible in England, by reason of the conditions of peace within her borders. The conditions are certainly not favourable for successful manufacturing development if the factories of a country are liable to interruption, or even destruction, by sanguinary conflicts arising between nations territorially conjointed. Economists say, and say rightly, that England's long start in successful manufacture and the acquisition of riches would not have taken place if there had been periodical irruption of hostile feet within her borders, as on the continent of Europe. A feeling of comfortable security as regards interference from without not only produced a state of ease and wealth in England, but enabled her capitalists to undertake enterprises in all quarters of the globe to the benefit of the world at large. This feeling of ease, security, and supremacy was accompanied by certain disadvantages which may be briefly stated.

The landed interests in England, and in all European countries, have always regarded themselves as a caste apart from, and superior to, the other citizens of the State. A premium of social esteem has attached to the business of land owning, and to the pursuits and pleasures of land owners, which does not obtain with those having other occupations. A stigma, or an amount of social disesteem, is attached to those who do not belong to the land-owning class, or to its closely attached and dependent professions. These facts are of great importance since the landed interests have usually constituted the governing classes, with all the privileges and power that appertain thereto.

The natural heritors of the successful British manufacturers of the sixth and seventh decades of this century have in many instances avoided the responsibilities incidental to manufacture, preferring to play the part of a country gentleman and to engage in the delights of hunting, shooting, fishing, etc., rather than the less-attractive pursuit of commerce. To the state of social opinion hereby indicated may be traced the decay of many factories, which well-informed enterprise would have kept vigorous and prominent. It has also kept out of the ranks of manufacture many men of mental capacity, who by reason of their trained intelligence would have been capable of foresight, application, and enterprise that have frequently been lacking.

It is an obvious circumstance that while the world moves or while there is such a thing as progress in manufactures, the factory installed by the latest comer is usually better than any factory installed many years before. The new comer has the accumulated experience of his predecessors to guide him, which naturally places him in a

better position economically than those who have to put up with disabilities that accrue even in the passing of time.

England has built up her manufacturing position essentially upon handicraft—the skill of the individual worker has been the dominant idea amongst the masses of the English people. Their intense individuality has scorned the idea of mechanical aids to industry, quite as much for this pronounced characteristic as from any fear of supplanted or displaced wage-earning capacity.

The supply of skilled and industrious workers in British industries has usually been ample. The skill and capacity of the better-class individual English worker is on the whole to-day, in the iron, steel, engineering, and allied trades, not inferior to the skill and capacity of the worker in any other nation. But while the best brains of America have been devoted to the honourable pursuit of industry, to developing mechanical ingenuity, to guiding, governing, and giving all those general advantages which a trained intelligence confers, such has not been the case in England. There were in England not only conditions of luxury and ease, but social ideas hindering trained and organised manufacturing development.

The first of commercial nations has not had a system of education fitting her sons to engage in commerce. The curriculum of our great public schools and our great universities has succeeded in training men fitted for some of the learned professions, but as regards commerce, or most of the practical affairs of life, our young men have left the universities quite unfitted, and with the necessity forced upon them of learning all that was essential after their "education" was "completed!"

Given a state of luxury and ease, and a premium of social esteem upon members of any and all professions which did not obtain with the participants in manufactures and commerce, it is obvious to any sociological student that there must be loss of place in any struggle for world or social supremacy. When to this condition there is added a lulling sense of ease and comfort and an induced belief in the permanency of pride of place and power, a sense of individualism, and an ample supply of workers, it is not difficult to account for the present position of England.

Since the consolidation of Germany and something like an equal balance of military power in Europe the prevailing conditions of peace have permitted a steady and continuous growth of industrialism.

Nations, like men, first supply the wants of their own household before supplying others.

During the past twenty-five years England has suffered a relative decadence of trade, and has not such a proportionately large share of the world's trade as she had at one time. Competition from without did not seriously disturb the mass of Englishmen, while the national sporting instinct says in effect, "let all have a try and let the best man win."

It is no new thing for England to have competition in her iron and steel, and allied manufactures. Hitherto it has been called "foreign competition," and the success of foreign competition is popularly explained by the "brute force" element in commerce, low prices. The reasons for successful "foreign competition" have been placed under the heads of cheap transport, low wages, long hours of work, and peculiarities possible under a protective-duty system. Now that the competition from without is "American competition," coming from our own kinsfolk, coming from such a quarter, it excites amongst English people in general quite a different state of feeling from that which obtained in regard to European competition. The prevalent view in regard to Belgian competition was, and is, that its success depends upon a standard of living and of comfort amongst Belgian workers inferior to that of the British workman, and the results are products inferior in quality and workmanship to average British ideas. As regards German competition, although there were, and are, features in it undesirable of emulation, yet German workers were apparently better cared for than Belgian, and the enterprise of her manufacturers showed courage and perseverance, entitling German competition to respect. Enquiry has shown that on the whole German pig iron and the heavier iron and steel manufactures are not produced at lower costs than British. But when goods are sold below cost of manufacture for export, and the makers are compensated by high prices in a protected home market, which enable a recoupment of losses incurred in export trade, then a certain feeling of resentment is incurred. The average man settles the point in a common-sense way by stating in effect, "if other people like to tax themselves in order to supply sugar, or iron, below the cost of production, more fools they. This process cannot go on for ever, and in the meantime it is good business for the buyers or consumers anyway."

In order to estimate the effects of American competition it will be well to examine experience with other and preceding competition.

During the past twenty years the Belgian manufacturers of wrought iron have succeeded in taking from England a considerable share of the export merchant trade in wrought iron destined for mar-

kets over-sea, where the question of price is of more importance than the quality of the article produced. Everyone engaged in handling Belgian iron would be able to testify from experience that the manufacturers thereof had, over a period of years, left themselves too small a margin of profit for possible contingencies to be able permanently to satisfy buyers who expected anything like precision of weights and sizes, or regularity of quality in their supplies. In past years it has frequently happened that the price quoted for Belgian iron has been one pound (£1) per ton lower than the cost of any other iron obtainable on earth. It is clear that this considerable disparity in price indicated either the measure of value in the estimation of the buyers, or an economic struggle amongst Belgian producers themselves to secure such orders as were going. The careful enquirer would ascertain that the lower prices at which Belgian products were offered were obtainable only by a condition of long working hours and low wages, such as English employers in general would be unwilling to see adopted in their own works, and such as English workmen in general would never accept without a struggle of prolonged intensity. Recorded mercantile experience shows that Belgian bar iron and sheet iron are giving way in favour of German products. The rapid development of soft-steel manufacture by the aid of the Bessemer basic converter in Germany has led to German producers offering basic-steel bars in merchant sizes and shapes, and basic-steel sheets at prices equal to, and in some cases lower than, those of the inferior Belgian products in wrought iron. The natives of markets like India, China, and Japan, were prompt to discover that German soft-steel goods would work up better, and with less cracks, breaks, and failures than were common to Belgian wrought iron. The consignments from German steel makers were superior to those of Belgian makers, not simply in that superiority possessed by soft steel over low-grade wrought iron, but in greater regularity of working to lengths, sizes, and weights. The eastern importer found, for instance, that the out-turn of a parcel of German steel was more likely to accord with the invoice than was the case over an average of transactions with materials of similar shape of Belgian origin.

It is necessary to dwell upon this phase of competition for markets external to England, because it illustrates what will probably happen in any successful American competition for the trade of neutral markets. American competition is already more feared in Germany and Belgium than it is in Great Britain.

Ordinary merchant trade is more readily acquired, or lost, than

that trade which is built up on specifications to meet engineering requirements, or in material ordered to comply with special conditions. On the engineering side I am doubtful of the ability of American steel masters to displace the use of British steel in structural work, where American suppliers claim a limit of phosphorus in their steel of .10, while British masters, in the open-hearth acid process, habitually work to a limit of .06. Every engineer knows that the lower phosphorus gives a better steel, safer in use, and will insist upon having low phosphorus while he can get it. Ordinary English steel-rail makers have no difficulty in working to a limit of .08 phosphorus. In higher-carbon steels, as now used for street and other rails, an English engineer will not accept a margin of 10 tons between the minimum and maximum breaking strains, while he can get closer and better working. The tendency and the practice amongst English engineers is rather to raise the standard of quality than otherwise. Too much has been said, or presumed, as to the inferiority of British iron masters in blast-furnace practice. It is true that the out-put from particular American furnaces, working rich ores, is superior in tonnage to British practice working on ores with a lower content of metallic iron. But figures that have come before me, from time to time, show that in the best practice the "yields" are good, and that pig iron is constantly being made in England with no higher consumption of coke per ton of pig produced than obtains in best American practice. There is at least one district in England, working on English ore, in which, under normal conditions, structural steel can be produced at as low a cost as any figures at present obtained in America, while if the close contiguity of coal to the Lincolnshire iron field, which of late seems assured, is taken advantage of, there will be British iron and steel masters capable of holding their own against all comers.

From time to time politicians in England—usually very unsafe guides in commercial matters—will be found publicly urging British manufacturers to alter their methods of doing business. Consular reports are published pointing out the deficiencies of Britain in certain particulars. When close enquiry is made into their recommendations their notions are found to be largely based on an idea that Englishmen should lower their average standard of quality and workmanship, or that they should give extended credit to buyers in countries that have demonstrated in past years a financial inability to meet their engagements at due date. Every man who has had practical contact with workmen or manufacturers knows how difficult it is to

obtain from individual workers, or from an individual manufacturer, at one and the same time the best goods and the cheapest possible goods. In vain is it for those unfamiliar with details, or not in practical contact with manufacturing, to urge those who are engaged in producing to imitate their rivals or to embark on a trade in inferior goods. In practice manufacturers somehow get sorted out into grades suitable for particular markets, according to the nature and quality of their products. But England is now beginning to recognise that if she wants to keep and to extend her trade in British manufactures, she must find some means of diminishing the disparity in cost between her own products and similar manufactures of other nations. The English people are a watchful nation, whether in the small matters of domestic life or in the small economies of manufacturing life. England has been wasteful in not having developed her splendid possibilities by systematically educating and training her people. The commercial success which has been gained by scientific application and method in Germany, and the mechanical ingenuity of America, are the factors that are showing her how to economise in her methods and to cheapen her products.

So far as figures go, America will doubtless remain for some years to come the largest producer of iron and steel. But something more than quantity and cheapness of product is required, and that is, that these things shall be obtained with a general well-being on the part of the workers engaged. Amongst other things to the credit of America, let it be said that her mechanical genius and industrial courage are making Europe understand that there is a dignity attaching to human labour, that man is worth something better than to act as a beast of burden, and where mechanical devices can be employed to dispense with the use of mere muscular energy, such aids fit men for higher and nobler purposes, happier and more useful lives.

The future of European iron, steel, and engineering productions depends largely upon the ability to ensure continuous cheap supplies of suitable raw materials. America will doubtless contribute to the continuity of supplies of raw materials in the shape of pig iron, and "partly-manufactured" steel. It is probable that there will be an increase in the number of factories in England established on the seaboard in suitable districts, at which American pig iron, soft steel in blooms, billets, slabs, and bars, can be worked up and turned into various products to meet constantly-growing needs of home and foreign markets. The ability to obtain such supplies from America will no doubt steady prices and prevent violent fluctuations in values in

Europe. Machinery and tools, from the United States, where they specialise and promote intensity of production, will be bought and adapted in various ways to the special and local needs of European users.

German methods and American ideas are modifying British practice and British ideas in manufactures and commerce.

There is an anecdote told of two men, a German and an Englishman, who were discussing military matters somewhat energetically. The German clinched his argument by saying: "I tell you if a war were to break out all Germany would fight like one man." To which the Englishman replied: "And I tell you, if a war were to break out every Briton would fight like all England." This anecdote may be taken to illustrate the difference in mental attitude between England and her chief commercial rival. Englishmen learn with difficulty to combine amongst themselves to a common end, or to exchange information for the common good. Their respect for individuality is carried to extremes. More weight is attached to opinions than to the ascertainment of facts. But earnest and capable reformers are struggling to secure a scientific basis for the education and training of the people.

The most successful profit-making British works are those where trained commercial intelligence dominates "practical" men, who are, however, invaluable in their properly subordinate positions. All these things are gradually being understood, and as they are more widely understood, will give rise to a feeling of dissatisfaction with the old men, the old methods, and the old factories which have outlived their period of usefulness.

American mechanical genius and cheap steel will not only raise the standards of comfort, but will multiply the wants of civilised mankind, which consumes more iron per head of population year by year. But in seeking to create and sustain an export trade in steel, America will find Belgium and Germany her most formidable competitors—particularly Germany, whose manufacturers thoroughly understand the art of combination to insure immunity from external competition. During the past ten years there has been a striking increase in the number of factories throughout Germany, which are boldly conceived, well-planned, and fitted and intended to last.

American competition will be more successful in British colonies, dependencies, and in neutral markets generally than in Great Britain itself, where it will act as a health-producing tonic that England has wanted for many a day.

THE CONNELLSVILLE COKE REGION.

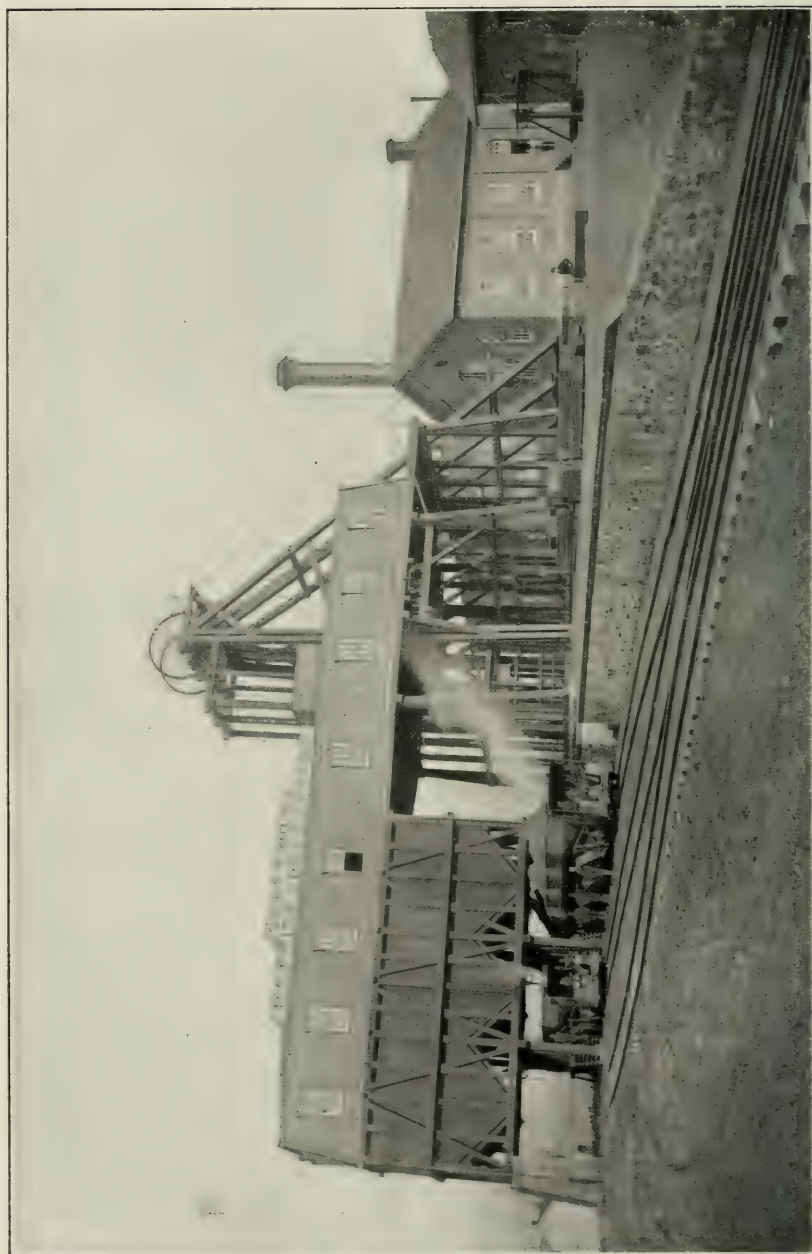


IT is said that when Mark Twain passed through the Connellsville coke region, he remarked that "it looked like hell with the lid off." Other people have, perhaps, not expressed themselves so warmly or so positively, but they have in some way conceived that the Con-

nellsville coke region is a most disagreeable section; in fact, the general opinion, except among those who have ascertained by personal investigation, seems to be that those portions of Fayette and Westmoreland counties that are the seat of the greatest coking operations on the face of the earth are a wild, desolate country, inhabited by a race of beings but little removed from the status of the savage. I am ready to admit that a ride by rail through the region when the coking industry is at high-water mark is anything but prepossessing, and is apt to give impressions that are far from the truth. It should be remembered that the railroads, as a rule, follow narrow valleys lined with rows of smoking coke ovens, while, perhaps, but a few hundred feet away over the hills are to be seen rich and beautiful landscapes.

The facts are that the Connellsville coke region is one of the most beautiful sections of southwestern Pennsylvania. It is not only rich in the mineral that is now one of the factors, if not the factor, that makes possible the supremacy of a nation, but it is rich agriculturally. Its wide valleys and rolling uplands yield a wealth of grasses, grains, and fruits that is unrivalled by any other section of the United States; in proof of which the view of the Mount Braddock farm of the H. C. Frick Coke Company will speak for itself. It is historic ground—the land of Nemacolin, the Indian warrior; through it passes Braddock's road, near which the unfortunate general was buried after the

The three great factors in America's rapidly-won prominence in iron and steel making are fuel, ore supplies, and labour economy. It would be hard to rank them in their true order of relative importance, but just now the newest and keenest interest centers in the study of the coal resources of the United States. We are glad to be able to present this comprehensive review of the region which has chiefly supported the vast American iron and steel trade—a review by one of the leaders and managers of the progress of the Connellsville region—as a concrete supplement to Mr. Seward's general discussion preceding. —THE EDITORS.



MAIN HOISTING SHAFT, STANDARD COKE WORKS, MT. PLEASANT, PA. THE LARGEST COKE PLANT IN THE WORLD.

disastrous reverse to the British arms at Braddock's field, July 9, A. D. 1755. The great national pike from Cumberland to Wheeling, which has been likened unto the Appian Way, passes through its heart; and it is watered by the tributaries of the Monongahela and Youghiogheny, supplying it with the finest of water from the springs of the Alleghenies, which is of the greatest importance in coke making, as it requires large volumes of pure water to produce a first-class article of coke.

Within the outlines of this coking coal field there are three important towns, or rather, young cities, viz: Uniontown, the county seat of Fayette county, Connellsville, and Scottdale. There are also a



THE MOUNT BRADDOCK FARM, H. C. FRICK COKE COMPANY'S PROPERTY.

Showing the character of the country overlying the Connellsville coal basin.

score or so of smaller places, all of which are to a great extent the result of the development of the coking industry.

The Connellsville coking-coal field proper is of limited area and extends from a point near Latrobe, on the Pennsylvania Railroad, in a southwesterly direction through Westmoreland and Fayette counties, a distance of 42 miles, almost to the Virginia line, with an average width of $3\frac{1}{2}$ miles, covering an area of 147 square miles, and, excluding barren measures, originally contained 88,000 acres, of which there are (I will say January 1, 1900), as near as I can ascertain, about 62,000 acres of available coal yet to mine. At the present rate of production, this coal would last fifty years; but if it should

increase in the ratio that it has in the past ten years, it would be exhausted in twenty-five years.

May 1, 1900, there were in operation in this region 89 plants, embracing 20,263 coke ovens, all of which are of the bee-hive type, excepting 50 Semet-Solvay ovens, which are being operated by the Dunbar Furnace Company, of Dunbar, Pa., for the production of coke and the recovery of the by-products. Of the 20,263 ovens, 19,751 were in full blast and 512 out of blast; 72 of the latter were under construction, and the remainder idle from various causes—principally lack of coal. The 19,751 ovens in blast were at that time producing coke at the rate of 225,000 tons coke per week, or about 13,000,000

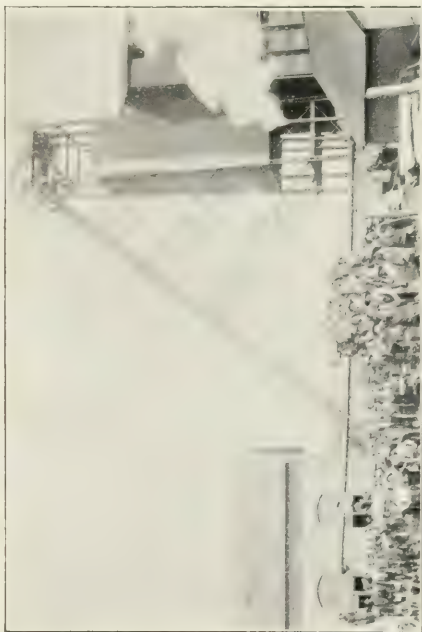
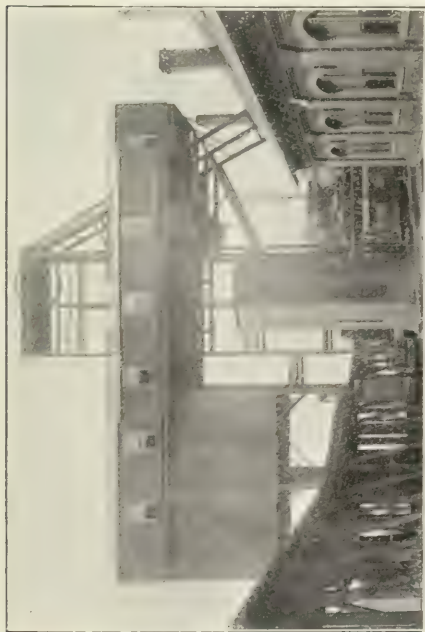


OLIVER COKE WORKS, OLIVER, PA.

Second largest coke plant in the world, having 708 ovens. Owned by the Oliver & Snyder Steel Co.

tons per annum. This is a great increase in production over last year, which was 10,129,764 tons; however, it is not likely that this pace will be kept up the whole year—in fact, there are already evidences of a lessened demand in the near future, owing to the falling off in consumption of iron and steel.

In the Connellsville coke region proper there are quite a number of new plants under construction, which, when completed, will bring up the total number of ovens to something like 23,000. In addition to this, there are a number of plants under construction in what is known as the "Klondike" region, which is just outside the limits of the Connellsville field proper to the southwest. These plants, when completed, together with those projected, will embrace about 4,000 ovens, which, added to Connellsville field ovens, will make a grand total of 27,000 coke ovens in Fayette and Westmoreland counties. Just what will be the result of all this expansion is somewhat of an uncertainty, but it would seem to be indicative of a rocky road ahead to those not making a high-grade coke, which so far the Connellsville region has had a monopoly of, with good prospects of holding it.



Leisenring Shaft, steel head frame, and ram.
Oliver No. 2 Shaft, and group of workmen.

Steel head frame and portion of coke plant, Leith Shaft.
United Shaft, H. C. Frick Coke Co.

SHAFTS IN THE CONNELLSVILLE COKE REGION



GROUP OF COKE DRAWERS, YOUNGSTOWN COKE WORKS.

From a photograph taken nearly 20 years ago.

This is a fair statement of the present condition of the industry. Prices paid for coke during the twelve months up to May, 1900, have been good, and the operators have shared with their workmen the prosperity that has fallen upon them by voluntarily advancing wages twice during the period. The scale of wages now in force is the highest ever known in the Connellsville coke region, and as a natural consequence there is a general boom in all lines of business.

The growth of the Connellsville coking industry is phenomenal, and a brief account of its inception and progress will doubtless prove of value to all interested in the iron and steel industries of the State. It is my good fortune to be a fellow townsman and an acquaintance of Mr. M. M. Cochran, President of the Washington Coal and Coke Company, of Fayette county, Pa., whose very extensive operations are located upon a tract of land formerly owned by George Washington, from which fact they take their firm title.

Mr. Cochran is a son of Mr. Mordecai Cochran (the real father of the Connellsville coke industry), and I have direct from his lips the following modest but very concise and reliable statement:

"Mordecai Cochran, in the year A. D. 1843, built two boats on the banks of the Youghiogheny river near Dawson, Fayette county, Pa. During the course of their erection, he made an arrangement with

Sample Cochran and James Cochran by which, in consideration of their contributing their labor in the building of the boats in question and in the manufacture of sufficient coke to load those boats, they were to have a one-half interest in one boat.

"Mordecai Cochran was a prosperous farmer and owned 300 acres of land, much of which was underlaid with the now famous seam of Connellsville coking coal. He, therefore, had within his own grasp all the facilities for the successful mining of coal, the manufacture of coke, and the means of transporting (the Youghiogheny river) the same to a market. The young men, Sample and James Cochran, helped to build the boats in question, mined the coal, manufactured the same into coke and loaded it in the boats, and these were floated down the river to Cincinnati, Ohio. Upon the arrival there, Mordecai Cochran went to see Miles Greenwood, the principal iron manufacturer and foundryman of the west. Mr. Greenwood said that he did not need the coke, and seemed to have doubts of its value as an iron-smelting fuel; however, Mr. Cochran finally persuaded him to send carts down to the wharf for enough coke to make a test. These carts were loaded with coke free of charge and the test was made immediately. Greenwood was greatly surprised at what he termed the wonderful heat of the strange fuel and the ease with which it melted the



GROUP OF COKE DRAWERS AT THE MAMMOTH WORKS.



STEWART COKE WORKS, UNIONTOWN, PA.

Showing coke ovens under construction.

pig iron, and he at once purchased the remaining coke at a very fair price. He told Mr. Cochran to go home and make all the coke he could."

This, without a doubt, was the great commission to initiate the manufacture of Connellsville coke and ship it as an article of commerce. It was the formal and complete introduction of it as an iron-smelting fuel, and from that time to this there has never been the slightest doubt as to the superiority of Connellsville coke over all other iron-smelting fuels. Until Mr. Cochran gave away those cartloads of Connellsville coke its value was unknown, and to him should be given the title of "the father of the Connellsville coking industry."

The coke made by Mr. Cochran was manufactured on the site of the old Fayette Coke Works, above Dawson, Pa. These pioneer works of the region were commenced about 1850, and were abandoned many years ago.

There are no records of the amount of coke manufactured, etc., in the Connellsville coke region previous to the year 1880, so that I cannot do more than annex a table of the yearly production, etc., since that date:

TABULATED STATEMENT OF CONNELLSVILLE COKE PRODUCTION, ETC.

Year.	Total Ovens.	Tons Shipped.	Av. Price.	Gross Revenue.
1880	7,211	2,205,946	\$.79	\$ 3 948,643
1881	8,208	2,639,002	1.63	4,301,573
1882	9,283	3,043,394	1.47	4,473,889
1883	10,176	3,552,402	1.14	4,049,738
1884	10,543	3,192,105	1.13	3 607,078
1885	10,471	3,096,012	1.22	3,777,134
1886	10,952	4,180,521	1.36	5,701,086
1887	11,923	4,146,989	1.79	7,437,669
1888	13,975	4,955,553	1.19	5,884,081
1889	14,458	5,930,428	1.34	7,974,663
1890	16,020	6,464,156	1.04	12,537,370
1891	17,204	4,760,665	1.87	8,903,454
1892	17,256	6,329,452	1.83	11,598,408
1893	17,513	4,805,623	1.49	7,141,031
1894	17,834	5,454,451	1.00	5,454,451
1895	17,947	8,244,438	1.23	10,140,658
1896	18,351	5,411,602	1.90	10,282,043
1897	18,628	6,915,052	1.65	11,409,835
1898	18,643	8,400,112	1.55	13,113,179
1899	19,689	10,129,764	2.00	20,259,528

An inspection of the foregoing table will reveal the fact that in twenty years the production of Connellsville coke has increased from 2,205,946 tons to 10,129,764 tons, or nearly five times the production of 1880. A further examination of the table will show that the Con-



OLIVER NO. 2 SHAFT AND GROUP OF COKE DRAWERS.

nellsville coke region has had its ups and downs—periods of great depression as well as periods of prosperity.

The following table will show the rates of wages paid from 1894 to the present time:

TABLE SHOWING PRICES PAID FOR COAL MINING AND COKE DRAWING.

	Jan. 1, 1894	Apr. 1, 1895	Oct. 1, 1895	Jan. 1, 1896	May 1, 1899	Mar. 1, 1900.
Mining and Loading						
— Room.....						
Coal per 100 bushels...	.75	.90	.95	1.05	1.12½	\$1.25
Heading coal.....	.86	1.02	1.08	1.20	1.27½	1.40
Wet heading coal.....	.91	1.10	1.16	1.25	1.32½	1.45
Drawing coke per 100..	.43	.50	.53	.60	.64	.72
Bu. coal charged.....						
Levelling per oven....	.07½	.09	.09½	.10¼	.10½	.12
Drivers, roadmen and timbermen, per day.	1.55	1.89	2.00	2.10	2.12½	2.35



TIPPLE, VALLEY WORKS, H. C. FRICK COKE CO.

Drift or water level type of mine.

The advances of April 1, 1895, Oct. 1, 1895; Jan. 1, 1896; May 1, 1899, and March 1, 1900, have all been voluntary on the part of the operators. I doubt very much if such an array of voluntary advances can be shown in any other industry.

The mining rate shows an advance of 66 2/3 per cent., the coke-

drawing rate an advance of $67\frac{1}{2}$ per cent, and the day-work rate an advance of $51\frac{1}{2}$ per cent. since March 31, 1895, making an average advance of over 61 per cent. in four years' time.

The seam of Connellsville coal, which is the basis of all this wonderful progress and gratifying prosperity, is one of the most remark-



COAL MINER AT WORK, VALLEY MINES, CONNELLSVILLE SEAM.

Showing full 9 feet of workable coal.

able in the States, if not in the world. It is pre-eminently a coking coal. There is no other seam that can compete with it in cheapness of production. There is no other coal so regular in formation; so uniform in quality; of so convenient a thickness (8 to 9 feet), or so easily mined. These are not mere statements, but facts—facts that have made Pittsburg the steel center of the world, and facts that in thirty years have been the means of bringing up the output of the blast furnaces of the United States from 30 tons per day to more than 700 tons per day. The following tables will show the quality of this coal.

The samples in the second table (p. 28) were taken from the Oliver mines by me and cover the full thickness of seam worked. The samples were analyzed at the Hainsworth Steel Works.

It should be remembered that a considerable percentage of the sulphur in the Connellsville coal is volatilized and driven off in the

coking process; therefore, the resulting coke is much lower in sulphur than the coal was before undergoing the operation of coking.

ANALYSES OF CONNELLSVILLE COAL, AS GIVEN BY U. S. GEOLOGICAL SURVEY.

Mine.	Fixed C.	Volatile M.	Ash.	Sulphur.
Henry Clay.....	61.49	32.40	5.10	1.01
Frick.....	60.92	32.60	5.40	1.08
Valley.....	63.78	30.60	4.50	1.12
Trotter.....	63.34	30.20	5.40	1.06
Eagle.....	62.68	27.90	7.50	1.92
Summit.....	59.80	33.80	5.40	1.00
Tip Top.....	60.90	32.10	5.60	1.40
Morgan.....	58.10	33.60	7.10	1.20
Foundry.....	65.36	28.40	4.90	1.34
White.....	63.30	28.80	6.80	1.10

ANALYSES OF SAMPLE OF COAL FROM OLIVER MINES.

	Moisture.	Fixed C.	Volatile M.	Ash.	Sulphur.	Phos.
Oliver.....	.800	66.35	26.70	5.35	.80	.015
Oliver.....	.359	61.17	31.70	6.00	.78	.016
Oliver.....	.600	63.10	29.50	5.85	.94	.014

The following tables of Connellsville coke analyses are a fair exponent of the product of some of the plants of the region:

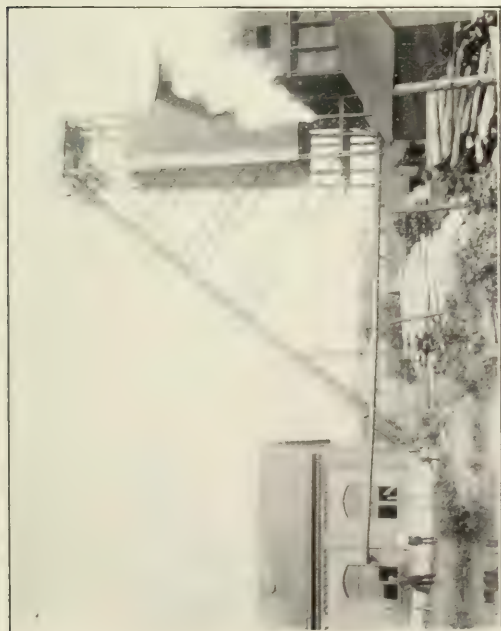
	No. 1.	No. 2.	No. 3.	No. 4.
Water.....	.030	.035	.036	.037
Volatile Matter.....	.645	.605	.535	.530
Fixed Carbon.....	89.405	89.740	89.350	89.733
Sulphur.....	.678	.673	.877	.636
Phosphorus.....	.013	.011	.010	.008
Ash.....	9.229	8.936	9.183	9.056
	100.000	100.000	100.000	100.000

No. 1 was 24-hour coke. No. 2 was 48-hour coke. No. 3 was 72-hour coke. No. 4 was 96-hour coke.

The coke from which the samples were taken for the above analysis was made by me at the Oliver Coke Works some years ago.

The following was given to me as the average analysis for three years of coke from the Connellsville coke region:

Volatile Matter.	Fixed Car.	Ash.	Sulphur.	Phos.
.60	88.70	10.80	.900	.018



Oliver No. 2 Shaft.
Another Oliver No. 1 Shaft.

Oliver No. 1 Shaft.
Henry Clay Tipple and Slope.

SHOOTS OF CONNELLSVILLE COOKING-COAL MINES

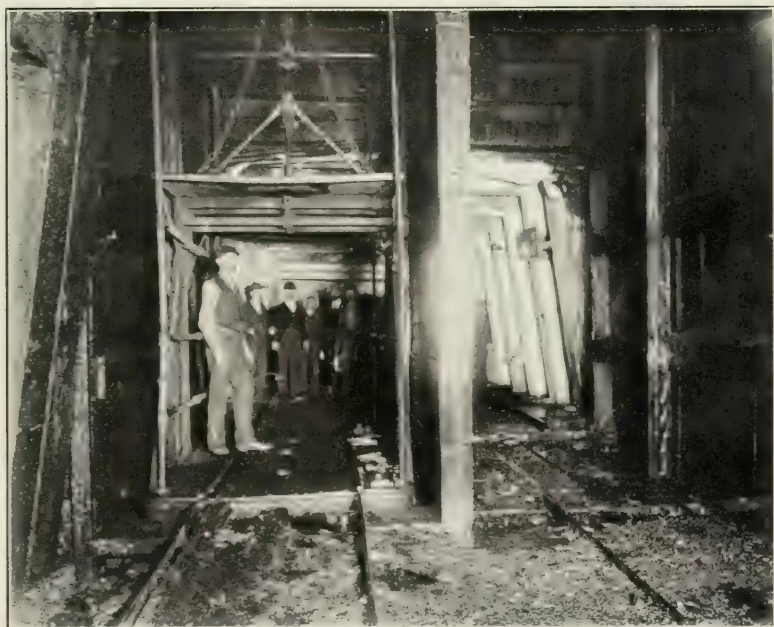
This is a very good showing, as it covers hundreds of samples from scores of plants all over the region. Of course, picked samples would show much better; in fact, I have seen picked samples of Connellsville coke that ran considerably over 90 per cent. carbon, but the above is good enough to satisfy the most exacting furnace operator.

A prominent blast-furnace man tells me that he wants coke to run not less than 85 per cent. carbon; not over 10 per cent. ash; not much over .75 per cent. sulphur; range of .010 to .020 phosphorus. These specifications can be easily filled by Connellsville coke.

It is true that the above chemical constituents can be supplied by much of the coke manufactured outside of the Connellsville region, but there are physical requirements (as well as chemical ones), and Connellsville coke invariably possesses these. It is further true that outside cokes, on analysis of picked samples, often exhibit a higher percentage of carbon and a lower percentage of ash, sulphur, and phosphorus, but they do not possess the necessary burden-bearing capacity, cellular structure, or uniformity. Perhaps the one great merit of Connellsville coke is its uniformity—it averages up well; that is what the iron makers want—high average results, not an occasional phenomenal showing. The fact that a certain coal can furnish a very pure coke, high in carbon, is not so satisfying as the fact that another coal does furnish a coke that is pure enough for his purpose and he can depend upon its being so always.

In the earlier days of the industry, the incentives for economical and exhaustive mining were not great. Large areas of the coal lay above water level, much of it with comparatively light cover, and of an inclination that furnished natural drainage and grades in favor of the load haul—a state of affairs presenting few or no difficulties to a mining proposition, and requiring no great outlay of capital for mine development or expensive openings, timber, etc. These conditions, together with the fact that Connellsville coal at one time sold at the ridiculously small sum of \$12 per acre and for many years remained less than \$100 per acre, gave the earlier operators the false idea that it was immaterial whether coal was exhaustively mined or not, and the result was that the mining was done in the crudest way and fully one-half of the coal area mined over in the earlier mines was lost. The mines were often opened up on the single-entry plan; the entries were of the most temporary character, and both these and the rooms were driven haphazard; there were no regulations as to width of rooms or pillars, and ventilation and mining engineers were regarded as expensive superfluities.

The earlier operations were of necessity of small capacity; therefore, skill and definite systems of mining were not essential to success, or at least, that which was viewed as success in those days. It was not until extensive operations became a feature of the industry that skill, definite systems of mining, machinery, and mechanical and mining engineers were considered factors at all; even then, if it had not been that coal lands became enhanced in value and the coal seam had to be attacked below water level, with adverse grades, mechanical drainage and ventilation, expensive openings, heavy cover, and immense volumes of water and fire damp to contend with, there would have been no strenuous attempt made to obtain from the seam the greatest possible yield and results. With these conditions imper-



BOTTOM OF OLIVER NO. 1 SHAFT.

This shaft is the second deepest in the Connellsville region, and the mine the most gaseous yet opened

actively confronting the operator, a radical change took place in the operations, methods, and appliances. Coal lands advanced in price from \$12.00 per acre to \$1,000, and at this day even \$1,500 per acre is not thought a prohibitive figure. The drift mines, with their single entries, natural drainage and ventilation, mule motive power, and an output of a hundred tons or so per day, gave way to immense plants, such as the Standard Shaft mine of the H. C. Frick Coke Co., at

Mount Pleasant, Pa. (the largest coke plant on earth), with its batteries of 908 blazing coke ovens consuming daily over 3,000 tons of coal and turning out daily 125 carloads of the silvery fuel that fears no rival. There, the drift or adit is replaced by the shaft that pierces hundreds of feet vertically the rocky stratum that but a few years ago was thought to seal from man its treasure of black diamonds. The mule is replaced by enormous engines; natural drainage by huge pumps; natural ventilation, by powerful fans; the hand dump, by the steam ram or pusher; and the lard-oil torch, by the electric light. Single entries are replaced by double and triple entries, and they and the rooms and pillars are laid out and driven with mechanical precision.

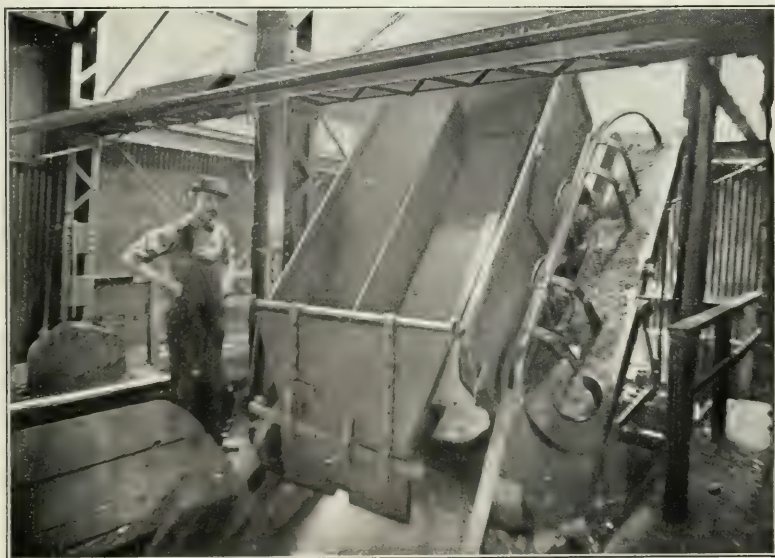


MINE FOREMAN'S OFFICE, 430 FEET BELOW THE SURFACE, OLIVER NO. 1 SHAFT.
(Mr. Keighley is on the left of the group.)

There are many fine operations among the 89 establishments that are marshalled under the generalship of the leaders of this great industry, but the space allotted forbids a description of all, and I shall attempt to outline only one more of the giant plants, and that one will be the Oliver Coke Works of the Oliver & Snyder Steel Co., located at Oliver, near Uniontown, Fayette county, Pa. (See page 20.)

This plant, with its battery of 708 coke ovens, is the second largest

in the world, and it is to a very great extent the result of the energy and foresight of Messrs. H. W. and George T. Oliver, prominent iron and steel manufacturers, of Pittsburg—the latter at the present time the proprietor and editor of the *Pittsburg Commercial Gazette*, Pittsburg, Pa. The mine workings are reached by two shafts, 415 feet and 387 feet, respectively, in depth. The workings proper were de-



TIPPLE HOUSE AND CAGE LANDING, OLIVER NO. 2 SHAFT.

Car just dumped, and still in position.

veloped under the six-heading system, *i. e.*, six parallel entries, protected by pillars of coal 600 feet in total width. The mine workings cover an area of 900 acres, which are, in turn, connected together by 46 miles of entries. The total area of the coal field at present tributary to the mine is 1,400 acres, leased from the estate of William Thaw, deceased, and more will be added when required. The coal is hauled from the various gathering points by two endless cables aggregating more than 20,000 feet in length, and a gravity plane is nearing completion that will be 10,000 feet in length; 700,000 gallons of water are pumped daily from the mine workings by the largest Yough pump ever made by the manufacturers (Boys, Porter & Co., Conneltsville, Pa.). The steam cylinder of this pump is 36 inches by 48 inches. The ventilation is effected by two Guibal-type fans 10 and 20 feet in diameter, respectively, moving nearly 300,000 cubic feet of air per minute. An extra 10-foot Guibal fan is held in readiness to

start up at any time emergency may require it. Forty head of horses and mules are kept at all times for use in the workings, and the same are stabled underground in stables built of brick and cement. The main headings of the mine are lighted by electricity, more than 300



TIPPLE HOUSE AND CAGE LANDING, WITH AUTOMATIC DUMPING CAGE,
OLIVER SHAFT NO. 2.

incandescent lights being in constant use about the plant. The workings are piped with fresh water supplied by pumps located on the bank of the Youghiogheny river at Connellsville, nearly 13 miles distant, and thrown over an elevation of nearly 600 feet. More than 300,000 gallons of fresh mountain water are consumed daily upon the premises.

The output of the mine averages 70,000 tons of coal per month, and the capacity of the coke ovens is 500,000 tons per annum. The shipment of coke from this plant for May of this year alone was 42,400 tons. Nearly 500 men are employed in the mine and 350 outside on the coke yards, etc., making a total of 850 men, with a monthly pay-roll exceeding \$40,000. The cost of the plant is considerably more than \$1,000,000.

The Oliver mines have been very difficult to operate, owing to immense volumes of fire-damp generated within the workings. Outbursts of fire-damp have occurred several times. On one occasion the fire-damp reached to the top of the shaft and for twenty-four hours it was impossible to go down the shaft. At another time, an

outburst filled the mine workings with fire-damp for a distance of 500 feet horizontally from the face in less than an hour's time. Three times during the life of this mine has it been necessary to tap the mine workings by means of bore-holes from the surface; yet during the whole of the nine years the mine has been operated, there has never been the slightest accident from fire-damp. This is in all probability largely due to the prohibition of the naked light and the rigid inspection enforced daily, no matter whether the mine is operated or not. The naked light was only used one day, and that was the first day the mine was operated. A force of five certificated fire bosses examine and report on the condition of the mine before a workman is allowed to enter. All underground employees work with a locked safety lamp, which is examined and locked each morning before being handed to them; however, much the same is true of all the more extensive workings of the Connellsville coke region, as fire damp is generated in enormous quantities in all the deep operations, and several of the mines have been the scene of appalling and heartrending accidents—for instance, The Reid Uniondale Mine, Leisenring Shaft No. 2, Youngstown Slope, Hill Farm, and Mammoth Mines.



MAMMOTH COKE WORKS. THE SCENE OF A GREAT ACCIDENT ABOUT TEN YEARS AGO. The writer of this article was superintendent of the mine, and was within twenty feet of the shaft mouth, having just ordered a cage to go down on, when the explosion occurred.

Of late years, owing to greater care, better methods, more efficient appliances, and rigid inspection, accidents from fire damp are rare within the confines of the Connellsville seam.

Those accidents, while dreadful of themselves, have been productive of much good, and to them may be traced the present mining laws of the bituminous-coal districts of the State of Pennsylvania. Before these accidents occurred, few dreamed of danger from fire damp in the Connellsville coke region, and I, in common with many other managers, for years went about work with a flaming torch in mines that are now worked exclusively with the locked safety. The accidents occurred mostly in presumed non-gaseous mines. For many years it was presumed to be an established fact that all coal mines above water level were non-gaseous, but some of the greatest explosions of late years throughout the States have occurred in coal mines above water level, though in the Connellsville coke region the fire-damp accidents have invariably occurred below water level.

The types of safety lamp now in use in the Connellsville coke region are as follows, viz.: For examination of the working places by fire bosses, inspectors, etc., the Davy lamp is almost invariably used, though occasionally types of the Clanny lamp are used for that purpose. For the workmen, the Clanny type, bonnetted and unbbonnetted, is largely used. The best lamp yet introduced is the Wolf lamp. This lamp has many good features, some of which are as fol-



THE HILL FARM MINE FIRE. TAKEN THE DAY OF THE GREAT ACCIDENT, JUNE 16, 1870.

Thirty-one lives were lost. The dark portion of the engraving, on the left, shows the smoke over the pit mouth.



MAHONING MINE. WHENCE RELIEF HEADING WAS DRIVEN INTO THE HILL FARM MINE
AT THE TIME OF THE ACCIDENT THERE.

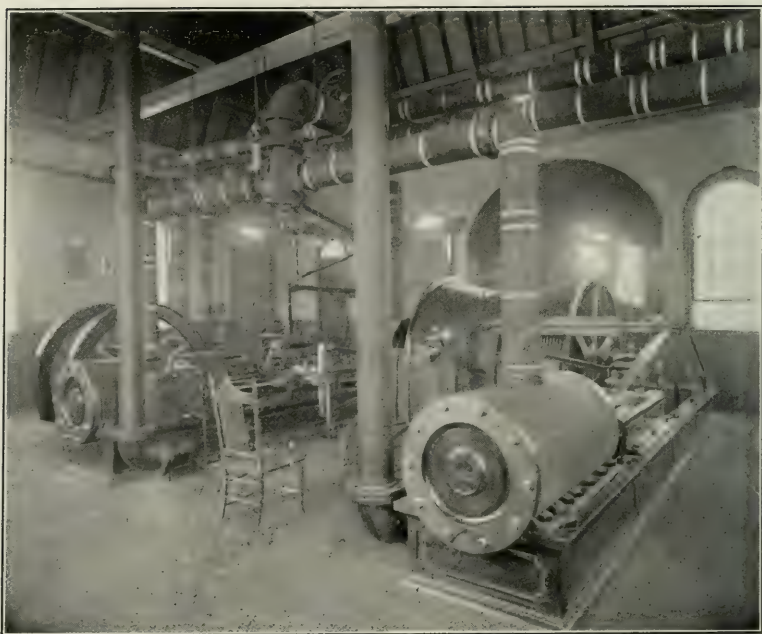
It was found to be impossible to reach the bodies by this route, and an exploring party of three, led by the writer of this article (who was mine inspector), penetrated over a thousand feet into the Hill Farm workings.

lows: It is always self-extinguishing in the presence of fire-damp, in explosive mixtures, or in case of being overturned; it is provided with a magnetic lock that cannot be picked; has an igniter by which the lamp can be lighted without opening it, and it gives a good light.

The ventilation of the mines is effected by means of furnaces and fans, principally fans, which are of the Guibal and Capel type—the latter being the coming fan.

The hoisting machinery is of the most substantial build, and almost always of the first-motion pattern, with differential drums at the shaft mines. At slope mines the machinery is both of the first-motion and geared patterns, with various forms of friction clutch. The pumping appliances are operated both by steam and compressed air, and include a variety of direct-acting patterns in single, duplex and compound noncondensing types of cylinder and plunger pumps.

Steam is generated principally by two-flue, fire-tube and water-tube boilers, with a tendency to the general adoption of the latter class with the vertical arrangement of the tubes, in preference to the horizontal and diagonal alignment. The tipping of the coal is largely done by automatic or self-dumping cages and the steam ram, though



HOISTING ENGINE, LEISENRING SHAFT NO. 2.

at slope mines the tipping is accomplished principally by means of drop-bottom mine cars and inclined trestling provided with a large bin placed immediately under the mine-car tracks. The coal mining is all done by pick-work; as yet, machines have failed to perform this work satisfactorily. The coal is very easily mined by hand.

The hauling of coal underground is largely done by some form of tail-rope or endless-rope haulage. At the Leisenring shaft No. 1 of the H. C. Frick Coke Company, compressed-air locomotives have been installed at a cost exceeding \$20,000, and are said to be giving most excellent results. These locomotives are of the high-pressure type, using air at a pressure of 500 pounds per square inch (manipulated by a form of reducing valve), and are very compact—quite a contrast to, and a great improvement over, the cumbersome low-pressure machine in use at mines heretofore. This, I believe, is the first attempt to use the compressed-air locomotive in the mines of this region, and it is viewed with greatest interest by the operators and mining talent generally.

Electricity is largely in use for stationary lights at the principal points about the mines and in the various buildings.

The mine workings are now developed by the two, three, four,

five and six-entry systems of mining. All the working places are driven on sights, *i. e.*, on lines given by the mining engineer. In some of the mines the retreating system of working has been adopted, and the aim is now to recover all the coal as nearly as possible. The most skillful mining-engineering talent is employed, and coal mining is rapidly becoming a science instead of a rule-of-thumb operation. The cost sheet is no longer considered by its monthly showing, as in former days, but by its relation to the general result during the whole term of the operation.

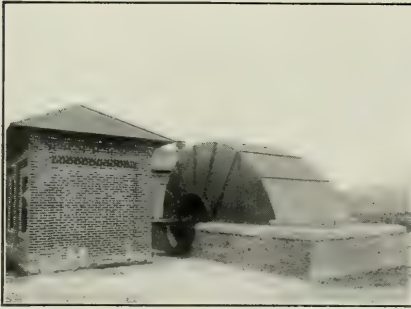
The coal (with the exception noted before) is all coked in the beehive type of coke oven, and the coke is drawn by hand, as machinery has so far failed to perform that operation either as satisfactorily or as cheaply as the human coke drawer. The coal is run directly from large bins, located near the mouth of the mines, into hopper-shaped cars known as larries, and these, in turn, are hauled



MINE AND YARD FOREMEN'S HOUSES, CONNELLSVILLE, PA.

Trotter Coke Works, H. C. Frick Coke Co.

to the coke ovens by locomotives or some form of rope haulage, and the coal is spouted out of the larries directly into the ovens. The levelling of the coal in the ovens (a very important operation) is performed by hand-work; in fact, there are very few mechanical appliances in use about the coke yards. The oven now being built is generally 12 feet-3 inches in diameter by 8 feet in height, inside measurement. The general form of the structure remains much the same as it was in the early days of the industry, the only marked difference being the increase in size and capacity.



16-FOOT CAPEL FAN, LEMONT WORKS.



GUIBAL FAN, ADELAIDE WORKS.

In closing, I cannot refrain from referring to the one man, who, of all others, has been the great factor in the building up of the Connellsville coke industry, which represents an investment of over \$100,000,000 and furnishes direct employment to 20,000 men. I have written of Mr. Mordecai Cochran as being the father of this industry, but Mr. H. C. Frick, of the H. C. Frick Coke Company, has been more—but for the physical incongruity of the term I would say that he was the mother, for it is he who has taken it into his arms an infant, as it were, giving employment to but a few hundred men, and nursed it year after year until it grew into the giant of to-day, employing over 20,000 workers—workers who are a credit to any land, for the workers of the Connellsville coke region are not by any means the degraded class of people that misinformed persons sometimes intimate they are. As a rule, a more orderly, industrious, and peaceable lot of men cannot be found in any industry. It is true there have been strikes and riots, but these never originated among the great majority; neither were they countenanced by them, but came from a few would-be dictators that no longer have a semblance of influence in the district.

The greatest concern of the region is the H. C. Frick Coke Company, founded and brought to its present unrivalled position by Mr. H. C. Frick and his lieutenant, Mr. Thomas Lynch. This firm at the present time owns 37,000 acres of coal; 12,000 coke ovens; 1,380 horses and mules; 17 drift mines; 22 slope mines; 12 shaft mines; 255 steam boilers; 35 steam locomotives; 150 stationary engines; 62 miles of coke-yard track or sidings; 350 miles of mine track; 6,243 mine cars; 21 air compressors, and employs 11,875 men.

All this has arisen in less than a business man's lifetime, and is a more eloquent testimonial than words to the ability of the men that brought up the industry from an infant in swaddling clothes to its present gigantic proportions.

ELECTRIC-POWER DISTRIBUTION IN GREAT BRITAIN.

By W. H. Booth.

THE late struggle for power to distribute electrical energy in Durham, Lancashire and South Wales that has recently taken place before the committee of which Sir James Kitson was chairman, and subsequently before the Lords committee, again draws attention to the huge claims of the municipalities to inter-meddle in anything and everything, irrespective of whether undertakings proposed to be carried out can or cannot be performed by such authorities themselves. It is difficult exactly to define the attitude affected by municipalities. In some cases their position appears to be simply that of a strong company able and willing to provide the common necessities of life, such as water, gas, or electricity, and perfectly competent to provide such at a price at which an outside profit-working company might find it difficult to compete. In other cases the opposition to the outside company arises purely from that peculiar conceit of the members of the local governing body that causes them to feel hurt in their dignity unless they can themselves control their little kingdoms in all things. This is apt to be the attitude of the smaller boroughs, and in many cases it arises from the occupancy of the mayoral chair by some strong man who carries with him the whole of the council or a majority of it, and, having been more than usually successful as a purveyor of soaps, sugars, and jam, thinks himself perfectly competent to undertake such affairs as electrical distribution. Were rate payers able to see behind the scenes they might sometimes be astonished to find how small was the real return from some of their boasted undertakings. There is obviously no *prima facie* reason why a municipal enterprise should not be constructed and worked with the same commercial success as an undertaking by a public company, and in some of the larger municipalities this may be the case; but in others, and in many small towns especially, the inter-meddling of the mayor, aldermen, and councillors is fatal to the best success. It has been known that the service of a tramway has been changed by some local alderman in the middle of the town without reference to the tramway officials, whose arrangements on other parts of the system went on as usual until matters came to the natural

stoppage resulting from such dislocation of traffic. One result of so-called municipal enterprise combined with short-sighted parliamentary action is seen in the astonishingly backward condition of Great Britain in respect of electrical undertakings, especially of tramways and power distribution. No country is so well adapted for both these as is Great Britain. The tendency of the cities, in common with most European cities, has been to concentrate themselves upon a small area. The introduction of railways did something to carry population into suburban districts. But railways soon found their limitation. They were costly to construct, and few towns had more than a couple of radiating lines, while the presence of the next station at a distance of several miles is evidence that the dispersal of congested population formed no part of the policy of the railways, while the persistent survival of the omnibus is proof that they did not succeed even where they attempted it. This failure of the steam railways arises from the fact that their expensive construction compelled them to confine themselves to narrow lines, whereas the ideal of the electric tramway is to occupy each one of the public roads leading out of a town, in order to distribute population over an extensive area rather than upon a narrow strip of land along one or two routes only. The object has been to take people further afield and to remove them from the unhealthy crowding of the city into more open country. The advantages of doing so have, it is true, been very largely eliminated or even entirely negated by the greed and rapacity of the speculative builder and the ease with which he has been able to build up unsanitary houses in the open country upon insufficient areas, unprovided with sufficient garden space, and without drainage, water supply, light, or any measures of sanitation or comfort. The narrow minds of the average local authority or officialdom have of course been opposed to the policy of dispersion of population, for they have viewed this as so much depletion of the rateable population. They would prefer to huddle their teeming millions into narrow courts and alleys rather than allow them to move further afield. In cases where such migration has taken place the boroughs have frequently sought powers to extend their areas. A notable example of this is Manchester, which at one time became retrograde through spread of population, coupled with trade stagnation preceding the construction of the ship canal. Manchester absorbed the new growths by extending her boundaries.

It is very clear that suburban traffic is one of the chief sources of income of the electric tramway—often, along certain routes, the only source. The experience of America points to the removal of con-

siderable masses of people from the towns. The narrow view that this necessarily implies reduction of taxable property cannot be allowed, even if true, to interfere with such movement. Obviously it cannot be true in any place so thriving as to encourage the promoters of a tramway to spend their capital therein, for the destruction of inferior houses can only mean the erection of better and more business premises to supply the needs of the growing suburban population. To the ordinary man of sense it would appear to be the duty of every municipality to expend its labour and energy in extending its borders so as to embrace what it considers to be its own population, and to provide for such population the sanitation and drainage necessary to their well-being—sanitation, drainage, and water supply being the fittest objects to occupy municipal enterprises and the least suitable for private enterprise. No one is injured when a family elects to sit in darkness because the head has fallen out with the gas or light-supply company. But the public suffer *en masse* when a water company fails in its supply or exercises its power of cutting off a supply in order to pay a bigger dividend or avoid expenditure. It has been particularly unfortunate for Great Britain that the selfish policy of the municipalities should have embraced electrical enterprise, because, if there is one thing more than another that is unsuitable for municipal control it is the generation and distribution of electrical energy, more particularly in the form of power. Fifty years ago the influence of the so-called agricultural interest was largely responsible for the legislation that killed the then hopeful automobile industry. The steam carriages of Gurney and Hancock had even then arrived at such a position of excellence as the vehicles of to-day can hardly be said to have yet reached, if due consideration is accorded to the differences of mechanical construction available now and then. This automobile legislation is responsible for the continuance of the congesting of population, which would otherwise have been checked by means of regular lines of automobile vehicles on all the roads out of the towns. The problem has remained to be solved by the electric tramway. The narrowest municipal view of electrical tramways would, if carried out, confine all such enterprises within the limits of the municipal area, and no system could be other than coterminous with the municipal boundary, while traffic would be confined purely to very narrow circles. The experience of America has shown that it is to suburban traffic that tramways must look for success, while such limited experience as has yet been gained in Great Britain not only supports the experience of America, but even shows that a very con-

siderable interurban traffic may be expected, and that this is nowhere more marked than along lines of communication already supposed to be served by steam railways. The amount of traffic to be picked up by any system of tramway or railway appears to vary with some power of the number of service units per hour. Unless, therefore, a tramway extend considerably beyond municipal limits it is very unlikely to pay. Yet the narrower municipal idea would sever the portion of line within a borough from that outside and utterly preclude any reasonable system of working. In the more liberal municipal mind the aspect is more extended, and while the ownership of the tramway within the municipal boundary is claimed for the municipality, the working of the line is leased by agreement to an independent company, while the provision of power may be the province of either party. Judging by the present attitude of the municipal authorities, it does not appear hopeless to expect that such joint agreements may be both frequent and satisfactory, nor does it appear outside reason that a town should have the control of the lines within its area, though it is obviously out of reason that any town should, through its officials, absolutely oppose the construction of tramways when such are a necessity for the well-being of the inhabitants. When, however, the general question of power distribution is considered, the case is altered. It is plain to the ordinary mind that Great Britain is not on a par with many other countries in this respect, and that the question of cheap power is one of great importance. Power cannot be manufactured and distributed with economy by a number of independent interests. The fundamental idea of power distribution is that the generation shall take place at some site where the ultimate sources of the power can be procured at a minimum of cost. In Great Britain, as a rule, this condition will be filled by locating the power house on a coal field. As the subject is one of national importance, it is clear that no narrow local interests should be permitted to intervene. Fully to carry out a system of power distribution demands that not only should the smaller towns and villages be supplied, but that the centres of population, the large towns, should be upon the same system. We may suppose two towns ten miles apart, A and B, with several small villages between. A is supplied by the distribution company. It will not pay to carry current to the ten miles of country beyond A, but it would pay to carry it to B, when the intervening area could payably be supplied from the mains. But B refuses to take current, thus practically depriving the country between of the advantages that would otherwise accrue to it.

In the case of the recent power bills it was obvious that the opposition had no grasp of the national importance of the interest involved. With the strong foreign competition that has now to be faced, each self-centred borough presented its little parallel to the fiddling of Nero. The declaration of the committee as to the additional claims to be embodied in the various bills was as follows:

1. The company to be authorised to supply electric energy for power purposes anywhere within the area of supply, subject to the consent of the local authority in certain cases as set out below.

2. The company to have no general lighting powers (*id est*, distribution to ordinary consumers) within the area, except in pursuance of a provisional order obtained in the ordinary way.

3. Where a local authority is now authorised to supply electricity within the area, then consent is to be required to the supply of electricity by the company. The Board of Trade to be empowered to override the refusal of the local authority to give consent, if the authorities are not prepared to provide the requisite supply on reasonable terms and within a reasonable time.

4. Any local authority who hereafter gets statutory powers for supplying electricity within the area, to have in ordinary cases the option of taking over the company's supply in its local area, on terms to be laid down by the provisional order or act by which the statutory powers are given.

5. A company having statutory powers to be in the same position as a local authority now having statutory powers, a company to whom powers are hereafter granted to be placed in the same position as a local authority to whom statutory powers are hereafter granted.

From the above it is seen that the power-distribution company is by (2) forbidden to supply current for lighting purposes unless by special powers. By (3) the company must not supply any current in any area supplied by a local authority, unless such authority consents. All experience tells that such consent will rarely be obtained unless compelled by the Board of Trade, and a long vista of local inquiries is opened up, for the authority is only called on to provide the *requisite supply at a reasonable price and within a reasonable time*. By (4) the local authority is to have power to take over the supply whenever it obtains power to supply current itself within its own area. Very extraordinary is (5), for this proposes to compel the supply company to sell its undertakings to some other company should such be formed. The whole cannot be termed satisfactory, nor evidence of the wisdom of the committee. With a broad scheme

before them, they have practically given way to the clamour of the municipal faddists and have placed one more obstruction in the path of British industry. Clause (3) will, it is to be feared, prove an unending source of trouble. The negotiation for the supply of any and every customer within such an area as falls within the scope of this clause will be subject to the arbitrary refusal of the local authority to allow such supply. Then will follow the appeal to the Board of Trade, if the would-be consumer has not already been frightened off his agreement by the worry and arrogance of the check already received. Assuming the question to have reached the Board of Trade, much depends upon the attitude of the Board and its interpretation of the term *reasonable*. It is unlikely that a local authority will be able to supply electricity as cheaply as a large power-distribution company. There is nothing to show that the Board of Trade may not allow, as a reasonable price to be charged by the local authority, such a figure as will render it impossible for the proposed customer to accept. To gain some idea of the kind of custom likely to be secured by a power company, a correct example may be taken, such as would fit hundreds of power users under the Lancashire scheme. A standard cotton factory requires an indicated power of 1,000 horse. A liberal fuel allowance is 2 pounds of coal per horse-power hour, and many mills run for less, but the still higher figure of 2.24 pounds will be assumed, for this represents just one ton of coal per hour. At 12 shillings per ton, with an allowance of 1 shilling per hour for the engineer and 1 shilling for fireman, and 1 shilling for oil and stores, the total is 15 shillings per hour. Interest and depreciation on the boilers, economisers and chimneys may add another 3 shillings, bringing up the total cost to 18 shillings per hour, the assumption being made that the electrical plant will cost as much as the engines and buildings displaced. The cost of electrical driving will be as follows: About 750 horse power will be called for, with motors placed on each line shaft, or let us even say only 500 units, so as to place electrical driving in a favourable light. The hours per annum will be 2,800, and the annual consumption barely $1\frac{1}{2}$ million units. To compete with steam, the price would then require to be less than one half-penny per unit, a figure which may usefully be compared with the price per unit supposed to be reasonable when granted by the Board of Trade to municipal stations as their right when supplying current for tramways, a figure which is apt to average more than three times the modest half-penny. Such large consumers as a 1,000 horse-power factory would however in no case be likely to come in as customers even when newly established, while if

they were already going concerns they would not soon be persuaded to discard the steam plant for an outside source of power. The other extreme is the small workshop, using very little power, and paying heavily for it—the little shop with small and wasteful engine and boiler, expensive attendance, and costly breakdowns and delays. The power in such a shop may run to the high figure of 5 shillings per horse-power hour, and a charge of even 6 pence per unit is to such a place a trifle. Between these limits there is a large field, not merely of small customers, but of that class of large customers with extensive works of a widely scattered character, the cost of power for which more or less approximates to the figure of the small works. Incidentally it may be remarked that the system of heavy charges for small users of current is not sound, because in the multitude of small users there is the potentiality of a steady load factor. If there is one thing that has particularly characterised the electric-light companies of this country it is the efforts made by them not to allow current to cease in their mains. Every effort is made to preserve supply, often under most discouraging and arduous conditions. The supply of power to a manufacturing customer is a duty that is fraught with far worse consequences in case of failure than usually ensue from the failure of light. The latter can be remedied by the use of other illuminants, but the failure of power is something against which there can be no remedy so reasonable in cost as to be allowed to enter into the question excepting in cases out of the ordinary. Indeed, the storage battery is practically the only remedy or safeguard, and it is one that will not be adopted unless with the inducement of a considerable abatement in the price per unit of current. It is tolerably certain that the supply of current by a local authority would not be received so favourably by consumers as the supply by a trading company that was dependent for a continuance of its trade upon the certainty and regularity with which it performed its duty, and against whom the consumer would not be without a remedy in the same sense that he would be in event of failure to supply on the part of the local authority. It is well known that municipal officials will expend money on legal proceedings to defend indefensible cases, simply because such money is not their own, while they may even secure a holiday trip to London as well-paid witnesses, and all experience points to the prospect that failures to supply will be greater and more numerous on the part of a local authority than by a trading company, and that remedy for default will be far more difficult to exact. Such a condition can have but one effect. When a consumer is bound to buy current from the local authority, or not at all, he will

probably elect to go without, and will adhere to his old and wasteful methods. The very end and aim of a national movement of economy will thus be frustrated to pander to the craze for municipal trading. The worst evil of municipal trading of this type is that it is not trading. The best markets are not secured, because it is considered policy to purchase in other directions. The best talent is not secured, because good men do not get along with a multitude of masters, and the best labour is not available, because there is too much consideration of votes and influence, and it has not been unknown for the officer of a local plant to be under the orders of a committee containing his own subordinates or insubordinates. All these and similar well-recognised difficulties of municipal undertakings will render the municipal distribution of power more costly than it would be in the hands of a large company generating power in a favourable locality. Few municipalities could distribute power economically without going beyond their own borders with mains and power stations. The tendency of the committee's clauses will be to deprive the areas claimed by local authorities of all the benefits of power distribution, and to curtail the power of the supply companies to distribute as cheaply as would be possible were the eyes of their districts not picked out. The sparser populated outside areas cannot be supplied alone, without the support of the better and more crowded boroughs. Such a prospect is not an alluring one. Again have the interests of the nation been frittered away by parliament as with the tramways act of 1870, again with the initial legislation of electric light, and now again with the power bills a deliberate stop is put upon industry. The investment of capital is hindered, and the one thing necessary to enable English manufacturers of electric plants to acquire experience and secure business that would enable them to compete abroad on similar lines, has been taken from them. For a long time the press has been full of complaints of the intensity of foreign competition. American locomotives, for example, to refer to a subject familiar to the chairman of the power bills committee, are running in Russia, Japan, Australia, New Zealand and South America, because certain English locomotive makers have gone more or less to sleep. Switzerland, a country where not a pound of coal is raised, has become a considerable manufacturing country, very largely because of the stimulus given to her industries by cheap power, for the natural water power of the country has been transmitted, and electrically transmitted, at what may be termed remunerative voltages. Compared with this energy, the sacrifice by the power bills committee of Ireland's interest to the hypothetical interests

of a few eels savours of the fatuous. It is indeed incomprehensible that Ireland's only source of power should be denied to the country, and small wonder that there should be a home-rule agitation to escape from the choking folds of such parliamentarians as now appear to control our destinies. It is certain that the prosperity of any country is so closely bound up with the possession of cheap power that the country will win in the race that first grapples with the problem of power provision in some communal form. A glance at the power consumers to-day shows the water-supply station busy pumping all day with a small night load, the electric-light station busy at night with no day load, blast furnaces throwing away millions of horse power all the year, tramways absorbing power twenty hours a day from coal burned in boiler furnaces. Were it possible to supply only the foregoing from a common fund the economy of fuel would be enormous. The advent of electrical transmission renders possible such an economy, as pointed out above, and a parliamentary committee says no. This economy will interfere with the desire of a few municipalities to supply power themselves by means of coal carried from a distance and burned under little knots of scattered boilers at extravagant rates and turned into power by wasteful little engines. It cannot be other than a subject for regret that such narrow and parochial legislation should obscure the prospects of futurity. The conclusion inevitably to be drawn cannot be other than that the members of the committee had no breadth of vision themselves.

The recent decision of the House of Lords committee that the Rushdale Corporation Tramways shall pay no profit, but expend all profits in reducing fares, is no doubt intended as a check on municipal trading. It opens a door, however, for an abuse that has been all too common in municipal affairs, for it will tend towards the payment of excessive prices for stores and other materials to favoured persons or firms, in which a suspicion of interest attaches to the officials and members of the various authorities. The almost inevitable result will be such carelessness in management as will probably result in actual deficiency. There will be very little difficulty in making no profit. Thus, no matter from what direction the question of municipal trading is looked at, very serious difficulties present themselves, nor has the management of undertakings that are essentially the duty of the municipality ever been marked by such ability as to warrant their interference in so national and vital a question as the distribution of power, wrapped up as it is with the better conservation of the one important service of national wealth, the coal supply.

THE USE OF WATER POWERS BY DIRECT AIR COMPRESSION.

By William O. Webber.

PROBABLY one of the oldest applications of the use of water power to the wants of man was a form of hydraulic air compressor which operated as an entrainment apparatus, and is the well-known water bellows or *trompe* of the Catalan forges.

This apparatus, briefly described, consisted of a bamboo pole disposed at a slight inclination from the perpendicular, into the upper end of which a stream of water was led, entraining air with it in its downward passage. The lower end of this bamboo pole was introduced into a bag made of the skin of some animal, the air being allowed to escape from the water into the upper part of the bag, from whence it was led by pipes or tuyeres to the forge, the water being allowed to escape from the lower edge of the bag. From this original device a great many improvements have been worked out, and besides this a number of other forms of hydraulic air compressors, or of compressors using other liquids for compressing air or other gases, have been designed.

A very simple form is a displacement apparatus,* consisting of a water reservoir and two air chambers of about three times the capacity of the water chamber. Water is led into the reservoir, compressing the air contained in it into the two chambers and giving a pressure of about 1.6 atmospheres.

Siemens invented an apparatus on the principle of the steam injector, but the use of this was confined principally to the production of a vacuum; it is used to operate the pneumatic dispatch tubes in London. It has also been used for blast purposes in Siemens' furnaces and in sugar works.

Another quite ingenious device, shown in a patent granted to W. L. Howe, consists of two flat plates enclosing an air space from which a pipe leads to the atmosphere. The upper plate is perforated with conical holes, the smaller end being adjacent to the air-space between

The movement toward fuller utilisation of the yet unrealised water resources of the world is one which is constantly quickening. With greater use comes larger study of adaptation of machinery and methods of water-power development and transmission. The peculiar means described by Mr. Webber has more than a passing interest.—THE EDITORS.

* Appleton's *Cyclopedia of Applied Mechanics*, fig. 138, page 37.

the two plates. Directly opposite the apertures of the upper plate are corresponding conical apertures in the lower plate, with the smaller end of the aperture next the air space, the lower and larger part of the conical openings being prolonged by tubes; the upper plate is kept under a head of water; the water jet, passing across the thin air-space referred to, draws in the air through the large air pipe and compresses it through the smaller orifices.

Another device using a somewhat similar principle was invented by M. Romilly* and consists of a conical tube attached to an air reservoir by its larger end, and having a check valve interposed in the passage so as to prevent the air from escaping. Water is then injected into the smaller end of this conical tube through an ajutage in the form of a liquid vein at a given pressure, which entrains the air with it and causes it to be compressed in the reservoir. But the apparatus just described did not really employ the same methods as those used in the old trompe. One of the first inventions carrying out this idea was made by Mr. Frizell, of Boston, Mass. His invention made use of an inverted syphon having quite a little horizontal run between the two legs. A stream of water was led into the upper end of the longer leg, and at the top of the horizontal run between the two legs of the syphon was provided an enlarged chamber in which the air would separate from the water, the water being then led off from the lower part of this air chamber and passed off through the short leg of the syphon, the pressure of the air accumulated in the air chamber being therefore due to the height of water maintained in the shorter leg of the syphon. This application of carrying upward the water, after the air was separated from it, so as to produce a considerable pressure upon the air, seems to have been original with Mr. Frizell, and in this feature his device differs from the old trompe.

Mr. Frizell made two working models of this type of apparatus. In the first one the legs of the syphon were 3 inches in diameter, the head of water being 25 inches, and an efficiency of $26\frac{1}{2}$ per cent, was obtained. A larger apparatus was then constructed at the Falls of St. Anthony, on the Mississippi River, a few miles above St. Paul; the longer leg of the syphon in this plant was 15 inches by 30 inches and the short leg of the syphon 24 inches by 48 inches in section; the height of water above the air chamber was 29 feet. The head in feet varied from .68 to 5.2, the first head being just sufficient to cause a flow through the pipes. The working head varied from 2.54 feet to 5.02 feet and the efficiency from 40.4 per cent. to 50.7 per cent., the quantity

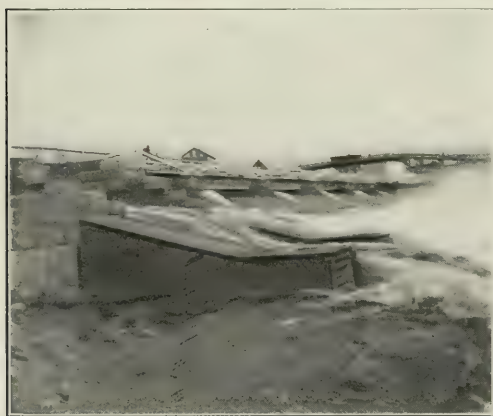
* Appleton's Cyclopaedia of Applied Mechanics, fig. 139, page 37.

of water in these cases varying from 5.92 to 11.89 cubic feet per second.

Mr. Frizell estimates from the experiments he has made that with a shaft 10 feet in diameter, a depth of 120 feet, and a fall of 15 feet, the efficiency would be 76 per cent., and with a head of 30 feet and a fall of 230 feet the efficiency would be 81 per cent.

Another device, differing somewhat from that of Mr. Frizell, was invented by A. Balochi and A. Krahnass in 1885, and consisted of a syphon carrying water from an upper reservoir down to another reservoir situated at a lower level, the lower end of the syphon being projected through an inverted vessel placed nearly at the bottom of the second reservoir. Just beyond the bend of the syphon, and in line with the vertical axis of the longer leg thereof, was an air pipe projecting into the descending column of water, thus entraining the air with the descending column, and carrying it down into the inverted chamber, where the air escaped from the top and the water passed out from the bottom of the inverted vessel into the lower chamber. This also produced pressure on the air in the top of the inverted chamber, due to the height of the water column upon it.

Another device, patented by Arthur in 1888, differs from the last in having a stream of water led directly into the top of the vertical pipe. Inserted into the mouth of this pipe was a double cylindrical cone, making an annular air passage surrounding the mouth into which the water was delivered. The water, after passing through the upper cone and there being compressed and its velocity increased, then passed into the inverted cone, where the velocity was somewhat decreased and the water became more diffused. This lower cone was



THE MAGOG DAM AT HIGH WATER.

perforated with holes opening into the annular air chamber previously described, causing air to be entrained with the falling water. Inside of this down-flow pipe was a vertical delivery pipe for the compressed air, having its lower end enlarged and open at the bottom. Projecting upward into this enlarged air-delivery pipe was a

water-escape pipe through which the water passed after having parted with the air. This escape pipe was in the form of an inverted syphon and maintained a pressure on the air in the delivery pipe, due to the elevation of the water at its discharge point above the air line in the large end of the delivery pipe.

A number of other patents on apparatus of this type were issued to Charles H. Taylor, Nos.

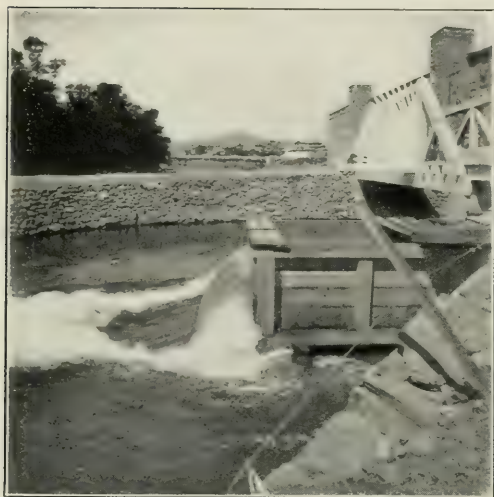
543-410; 543-411; 543-412, July 23, 1895; his invention consisted principally of a down-flow passage having an enlarged chamber at the bottom and an enlarged tank at the top. A series of small air pipes were projected into the mouth of the water inlet from the large chamber at the upper end of the vertically descending passage, so as to cause a number of small jets of air to be entrained by the water, Taylor seemingly having been the first one to introduce the plan of dividing the air-inlets into a multiplicity of smaller apertures evenly distributed over the area of the water inlet.

Taylor at first seems to have attempted to utilize centrifugal action in causing the separation of the air and water in the large chamber at the bottom of the compressed column, but afterward abandoned this scheme and used, instead, forms of deflector plates in combination with a gradually-enlarging section of the lower end of the down-flow column in order to decrease the velocity of the air and water and cause partial separation to take place, and also using the deflector plates to cause the water to change its direction of flow, evidently with the idea that the air would escape more readily.

The latter improvements on this device have been in the method of introducing the air into the mouth of the downwardly-flowing water column, so as to insure the largest proportion of air being taken down with the water, and in methods of decreasing the velocity of the combined air and water at the bottom of the descending column, causing



THE WEIR BOX AT MAGOG, FROM THE BRIDGE.
Observers taking readings from the hook gauges.



THE WEIR, SHOWING FORM OF WAVE CREST.

the water to part more readily with the air, the water then passing out at the bottom of the enlarged chamber into an ascending shaft, maintaining upon the air a pressure due to the height of water in the uptake, the air being led off from the top of the enlarged chamber by means of a pipe.

The first one of these compressors on the Taylor principle was installed at Magog, Quebec, to furnish power for the print works of the Dominion Cotton Mills Company. The head of water is 22 feet; the down-flow pipe is 44 inches in diameter, and extends downward through a vertical shaft 10 feet in section and 128 feet deep. At the bottom of the shaft the compressor pipe enters a large tank 17 feet in diameter and 10 feet high, which is known as the air chamber and separator.

A series of very careful tests on this plant demonstrated that out of a gross water horse power of 158.1, 111.7 horse power of effective work in compressing air has been accomplished, giving therefore an efficiency of 71 per cent. It is found that the air after compression shows a very considerable decrease in moisture from that of the air entering the compressor, although in contact with the water

the water to part more readily with the air, the water then passing out at the bottom of the enlarged chamber into an ascending shaft, maintaining upon the air a pressure due to the height of water in the uptake, the air being led off from the top of the enlarged chamber by means of a pipe.

The first one of these compressors on the Taylor principle was installed at Magog, Quebec,



COMPRESSOR HEAD TANK AND WEIR.

The air compressor is blowing off.

all the time. This is probably due to the moisture in the bubble of air being pressed or squeezed out to its surface and then absorbed by the surrounding water. The air is compressed at the temperature of the surrounding water and the compression is isothermal. Owing to these facts there is no loss by heat of compression and again by radiation, in using the air, and there is a practical result which is of more importance:

the hydraulically-compressed air can be expanded down to a temperature much below the freezing point, while atmospheric air with its usual amount of moisture, mechanically compressed, cannot be



THE MAGOG MILL AND WEIR.

All the water passing over the weir has passed down through the air compressor.

used at all, owing to the freezing up of the exhaust passages of the motor in which the attempt to use it is being made.

The accompanying photographs give an idea of the extent of the plant and of the volume of water used. The last one, showing the air carried in suspension, is especially interesting. The air cloud may be traced in the water quite as distinctly as it is shown in the photograph, for 40 or 50 feet below the weir.



VIEW TAKEN BY POINTING THE CAMERA DIRECTLY DOWNWARD OVER THE EDGE OF THE WEIR.

The clouds are made by the finely-divided particles of air carried in suspension. In the limpid Magog water these may be traced 40 or 50 feet below the weir.

THE CENTRALISATION OF THE STEAM-CONDENSING PLANT.

By Harry G. V. Oldham.



URING the last ten years the problem of the economical condensation of steam has attracted considerable attention in Great Britain and America, and also on the Continent. An impetus has been given to the manufacture of condensing plants by the demand from the large number of electric-light and power stations that have sprung up all over the country. The conditions that prevailed previous to the time of this demand do not now obtain; in fact, except in marine practice, steam users were content to allow the steam to exhaust into the atmosphere, and even now there are large units so dealing with their useful work.

One of the principal reasons of this waste of power is an insufficient supply of water, and even where a constant supply of water is available, if from a town main, the cost would prohibit it being used for condensing purposes, if there were no method of using it over again. It is now possible, by the use of a cooling tower or evaporative condenser, to reduce the quantity of water required for condensation purposes to less than that of the boiler feed—*i. e.*, a steam plant can use less water when condensing than when non-condensing. The saving in the coal bill due to the reduction of the back pressure on the piston is so well known that it need not be enlarged upon here. This reduction of back pressure is due entirely to the efficiency of the condensing plant and its arrangement, and to the use of a carefully-designed air pump and connections.

One objection made to fixing a condenser at any great distance from the engine is that trouble is experienced with the increased number of joints. In several cases, however, it does not seem to have been

The whole story of the vast growth of steam-using is written under the one text—constantly-bettered economy. Higher efficiency has made possible larger applications, greater installations, higher speeds, longer runs. We have long learned the advantage of centralising the steam-generating plant—the *positive* reservoir of the steam-power plant; it is rather to be wondered at that the study of the economy of centralising the *negative* reservoir—the condensing apparatus—has been so long deferred.

Newcomen used the engine cylinder itself as the condenser; Watt made the first great step in improvement by introducing the separate condenser; another great stage in the evolution of steam economy on the farther side of the engine is marked by the movement toward centralised condensing plant. Mr. Oldham's comprehensive study of the subject has therefore a great as well as a comparatively new interest.—THE EDITORS.

the intention of the maker to bestow very much care on the design and erection of the exhaust main, some joints being made with the flanges not even machined; when the pipe has been made of steel plates, moreover, the rivets have been so far apart as to make it im-



CENTRAL CONDENSER WITH COOLING TOWER, ST. LOUIS STAMPING COMPANY'S WORKS, GRANITE CITY, ILL.

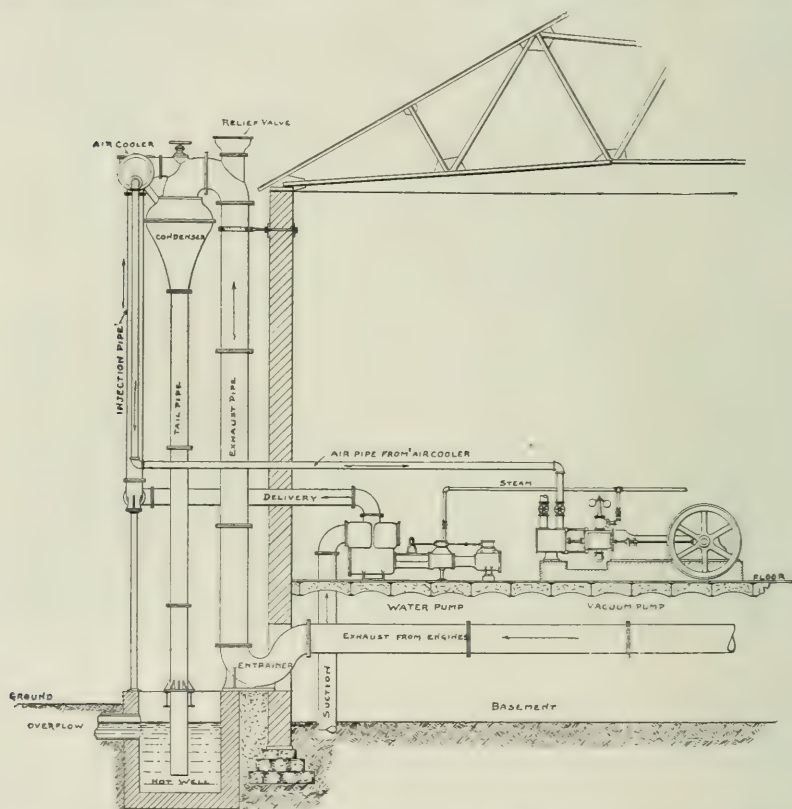
The plant maintains a vacuum of 24 inches upon four tandem-compound Corliss engines for driving plate rolls, no water-supply for condensing purposes being available.

Henry R. Worthington, N. Y.

possible to caulk the edges properly without buckling, and the flanges have been so thin as to put a tight joint out of the question. For this reason condensers that can be placed near the engine are sometimes preferred. But exhaust pipes can be and have been made that, in a distance of hundreds of feet, admit of a drop of only fractions of an inch in the mercury gauge. Of course considerable care is taken in the design and manufacture of such pipes, and, moreover, they are tested under a severe water test, both at the works and after erection.

The same thought and care should be bestowed on this important

run as are expended on steam pipes—perhaps even more. Therefore, if this is borne strictly in mind, there is no reason whatever why a condenser should not be placed at a considerable distance from the main engines. There is no need to do this, however, when stations are being newly constructed, as a place can be provided within a reasonable distance of the main engines. It is not necessary then to split the condensing apparatus up into small units and attach one to each engine. The condensing apparatus can be set apart by itself and its capacity



OUTLINE VIEW OF WORTHINGTON CENTRAL JET CONDENSER, SHOWING WATER AND VACUUM PUMPS, AND RELATIVE POSITIONS OF THE SEVERAL PARTS.

be made such as will deal with the whole of the steam given out from the boilers. This presents no disadvantage, no more than does the whole engine installation, which depends on a single battery of boilers coupled up to one steam main.

The condensing plant should be looked upon as a separate institu-



ONE OF NINETEEN WEISS CONDENSERS INSTALLED BY THE CARNEGIE STEEL CO.

Condensers of this type are built capable of handling 300,000 lbs. of exhaust steam per hour.

They will work with condensation water at 125 degrees to 400 degrees

F. temperature. Southwark Foundry and Machine Co.

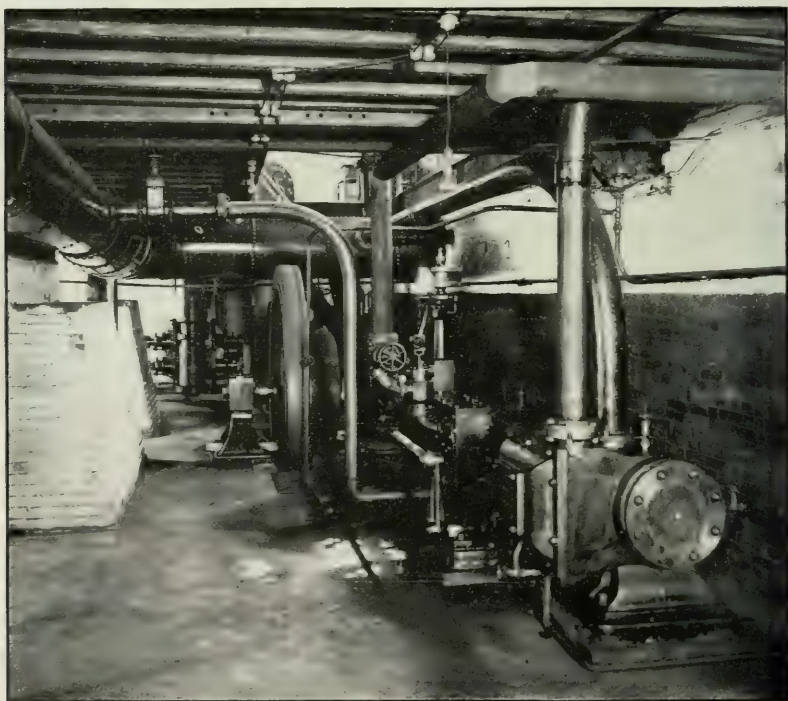
tion. In such case the air and circulating pump are put in operation and a vacuum produced immediately before the main engines are started; this is especially valuable when engines have to start under their full load.

In the case of steamships considerable saving may be effected by the use of a common condenser and independent air pumps. At present, as long as the main engines are running, the auxiliaries may dis-

charge their exhaust steam into the main condenser, but when the vessel is in port and the main engines are shut down, during the whole time of loading and unloading, the auxiliary plant has to exhaust to atmosphere if there are no independent air pumps. This auxiliary plant often includes powerful electric-lighting engines. It follows that there must be a considerable loss here due to increased coal consumption, besides the inability to use the condensed steam for boiler-feed purposes.

It is not proposed in this article to deal with installations where a large quantity of water is available for condensing purposes, but this case is mentioned inasmuch as it shows the advantage of an independent air pump and condenser.

In arranging a centralised condensing plant there are several important points to be taken into consideration, which for the most part are raised by the work required in the external service or the character of the load upon the engines. In the case of an electric-lighting station the load during the day is only small compared to that thrown upon the engines a few hours after sunset, whereas at stations generating



AUXILIARY MACHINERY FOR THE WEISS CONDENSERS SHOWN ON PAGE 53.

electricity for street cars the load is within certain limits constant, as also is the case with factory engines. In the latter case only a small subdivision of the condenser is rendered necessary, such as would allow one section to be eliminated for any slight repair, without in any way interfering with condensation of the steam. Such portion should constitute a reserve, as in the case of one (or perhaps two) elements in the boiler installation. It is not suggested the condenser should be one huge apparatus, such as one boiler to supply the whole of the steam for an extensive plant, but it is desired the arrangement of the condenser plant should be similar to that of a boiler plant—*i. e.*, its position should be central, a spare section should be provided for (although under exceptional circumstances the engine could exhaust to atmosphere), and the connections should provide for cutting out any particular element.

In dealing with an installation like that mentioned in the former case, where the maximum supply is required during a few hours of the day, the same principle holds; but provisions must be made for cutting out an entire element in conjunction with the engine it serves. It is advisable here (we are dealing with large units), to apportion a separate element of the condensing battery to each engine unit. The two may then be cut out and started simultaneously. This is not absolutely necessary except where separate air and circulation pumps are connected dealing only with this element. At full load all the junction valves would be open and the condenser would form one continuous apparatus. The evaporative condenser adapts itself very well to this purpose. In an arrangement of this type there is a stage at which the air and circulating pumps reach dimensions which it is not desirable to increase, and it is at this point where the sub-division should commence.

The most recent arrangement of surface condenser and cooling towers is the one in which a surface condenser, with its air and circulating pumps, is placed between two engines and receives the steam from both. Engines of 800 to 1200 indicated horse power are dealt with in this manner.*

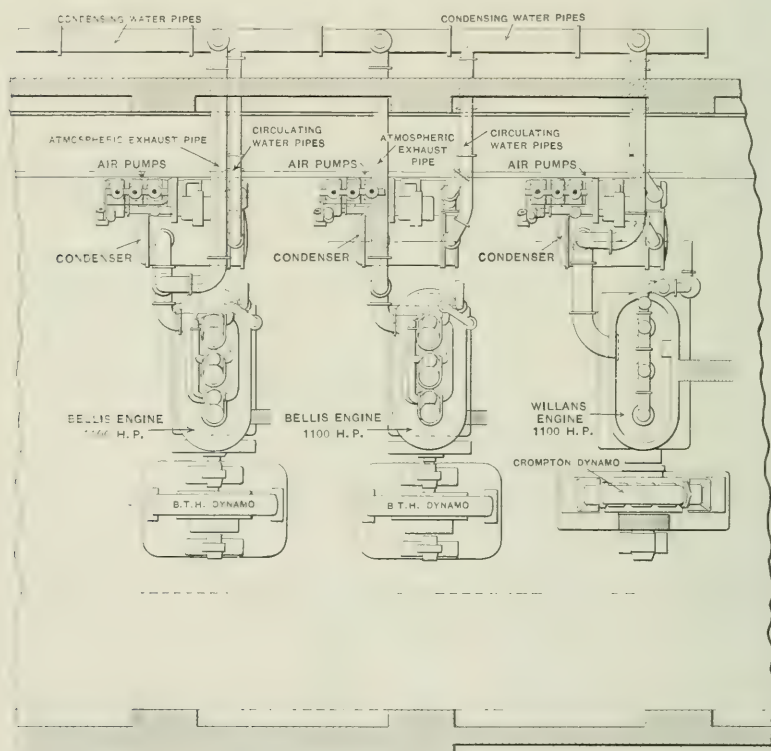
The condenser is sometimes placed below the floor level, to avoid taking up space on the engine-room floor. Where this arrangement of the condenser is adopted it is the cooling tower that is centralised, as the water from the whole of the condensers is delivered over a battery of towers. Each pair of engines may exhaust into the condenser,

* Throughout this article, 20 pounds of steam are assumed as the quantity necessary to develop one horse power.

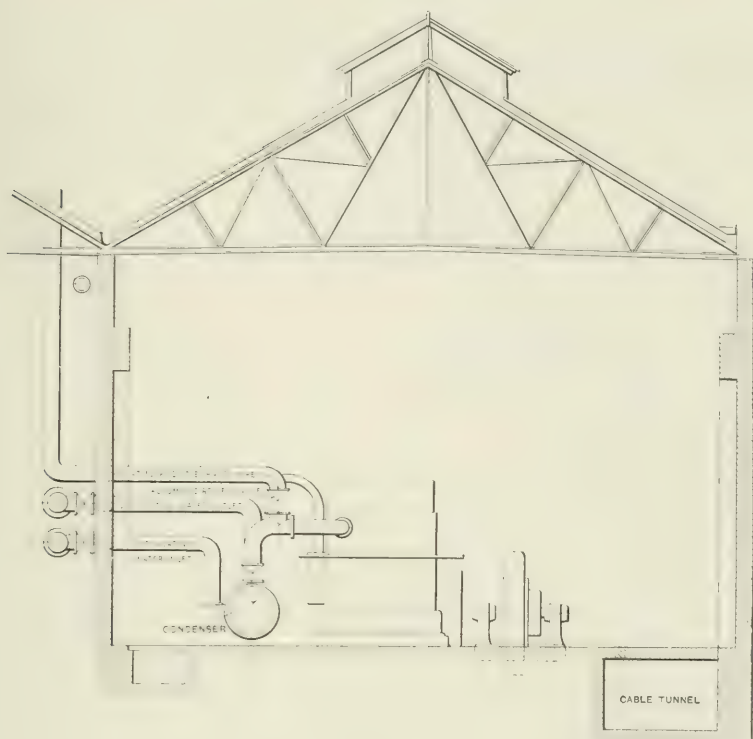
or only one may do so; in the latter case the speed of the air and circulating pumps is regulated to conform to the smaller quantity of steam.

Therefore, summarising briefly: the most economical system to adopt, when the engines are small and placed in different parts of the building and the load fairly constant, is a single condenser arranged in a central position (with its air and circulating pumps), taking the steam from all the engines through one exhaust main; when the engines are large and the load is uniform, the same arrangement may be adopted with complete success; lastly, when the load is variable and this variation is great and the maximum is only maintained for a few hours during the day, then each engine or pair of engines should have a separate condenser (but only in the case where the engines are of high power), thus enabling the entire unit to be cut out.

Such an installation is shown below, and has been adopted by Mr. W. A. Chamen at Glasgow. Each engine has its own con-



ARRANGEMENT OF ENGINES AND CONDENSERS, PORT DUNDAS ELECTRICITY STATION, GLASGOW. PLAN.



PORT DUNDAS ELECTRICITY STATION, GLASGOW. SECTION THROUGH ENGINE ROOM, SHOWING ARRANGEMENT OF CONDENSERS.

denser with independent electrically-driven air and circulating pumps. Each set of engines is of 1,100 horse power at economic load, and capable of working up to 1,500 horse power on emergency load. The pumps are the Edwards type, with three cranks, and each circulating pump will throw 108,000 gallons per hour. A Blake & Knowles automatic exhaust valve is fitted to each engine. A photograph of the air and circulating-pump set is shown later on page 67. Each condenser has 2,500 square feet of surface.

The circulating-water delivery pipes may be carried to the cooling tower, or, as in this case, to a canal.

It is advisable to get the condenser as near the engines as possible for obvious reasons, and this is followed out in the latest arrangement of surface-condensing plants with cooling tower; this arrangement works well provided there is available space in the engine rooms for the condensers. But in some cases, where the engine units are small, this has resulted in having a number of condensers scat-

tered all over the place, which is, as before mentioned, a very undesirable and uneconomical condition, with a heavy first cost.

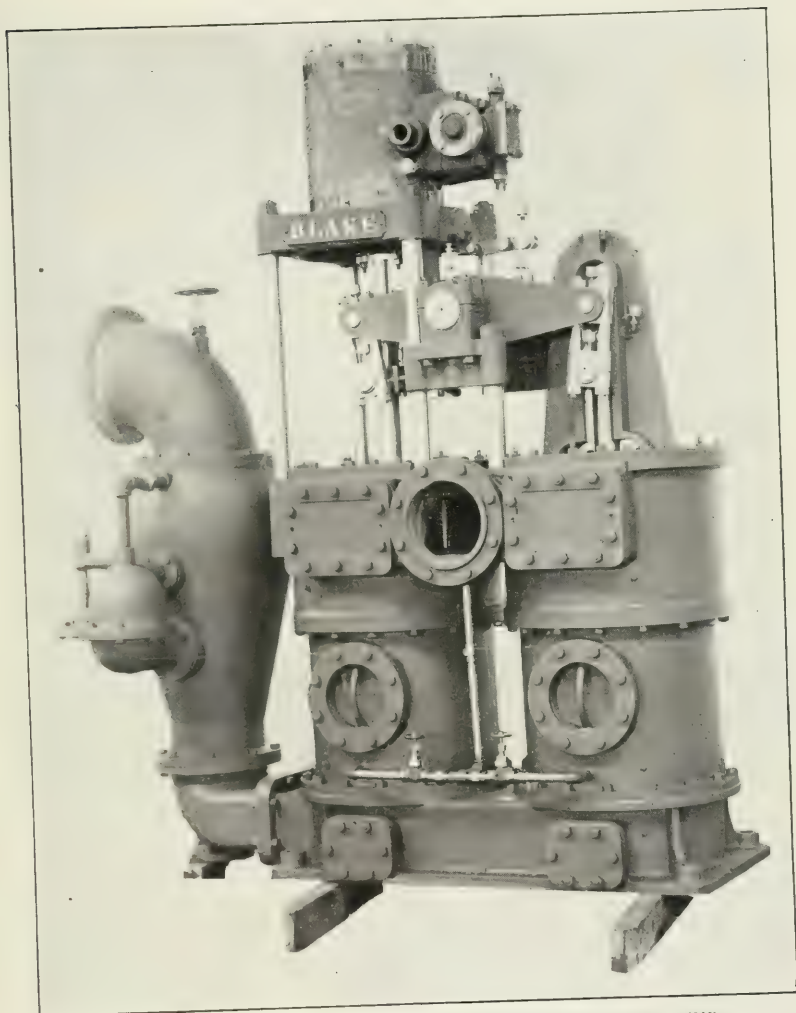
It would be interesting to mention here an installation at Messrs. Vickers Sons & Maxim works, Barrow-in-Furness. In this case all the engines are connected to a surface condenser capable of dealing with 20,000 pounds of steam per hour and equal (on a basis of 20 pounds steam per indicated horse power) to 1,000 horse power. There are probably thirty engines coupled up to this condenser, including the small shop engines.

After all the only conclusion that can be arrived at, whether the condensing plant be jet, surface, or evaporative, is to centralise it. It is the most economical arrangement. The exhaust pipe can be made just as sound, and very little trouble need be experienced with leaking joints.

Keep the condensing plant out of the engine room whenever possible. This brings forward a question in connection with the design of the station, and it is here that it is highly important that the disposition of the condensing plant should be considered—in fact, that it *must* be considered. Ground space in any work is in most cases limited, often very limited, but there is space available above the engine room and boiler house that can be made use of.

Provided ample light can be admitted at the sides of the building, the engine-room roof can be made flat; but should the position necessitate the roof being used for the admittance of light, then the boiler-house roof may be made flat, and it is generally the case that one of the two may be so treated. Make the boiler-house roof flat, properly built with girders and concrete; in some cases the cast-iron or steel tanks may form this roof. The best method, however, is to finish the roof in concrete, though this is more expensive. Upon this roof the condensing plant may be placed; the run of pipe from the engines is then very short, depending practically upon the height above the engine-room floor; a direct run can be taken almost free of bends from the engines to the condensers.

In an arrangement of this type the air pumps are in the engine room and the circulating pump on the roof, or, if possible, just below. The efficiency of evaporative condensers is increased by their being exposed. The surface condenser would be better under cover, nothing being gained by exposing this type to the atmosphere; but the cooling tower is in exactly the same case as the evaporative condenser, and should be free on all sides to the atmosphere. Cooling towers that have a fan circulating air through them need not be dealt



BLAKE SURFACE-CONDENSER SET OF AIR AND CIRCULATING PUMPS.

with in this manner, but the efficiency of the apparatus is increased if the atmosphere is all allowed free play all 'round it. The top, however, must always be open to the air, to allow the vapour to escape.

Surface Condensers.—The internal construction varies very little from the marine type: improvements have been made in securing a sound joint at the tube ends. In the Worthington condenser one end of the tube is flanged and held firmly by a screwed bush, while the other end passes through an adjustable gland which allows free expansion of the tube. Sometimes the Thornycroft expanding or split

ferrule is used; this has the advantage of keeping tight in the tube plate. W. H. Allen & Son countersink the ferrule and round the ends where the circulating water is delivered, so as to give the water an easy flow. They found by experiment that this reduced their pumping head by 3 feet. The external form is usually round or rectangular, with the air and circulating pumps or combination sets placed



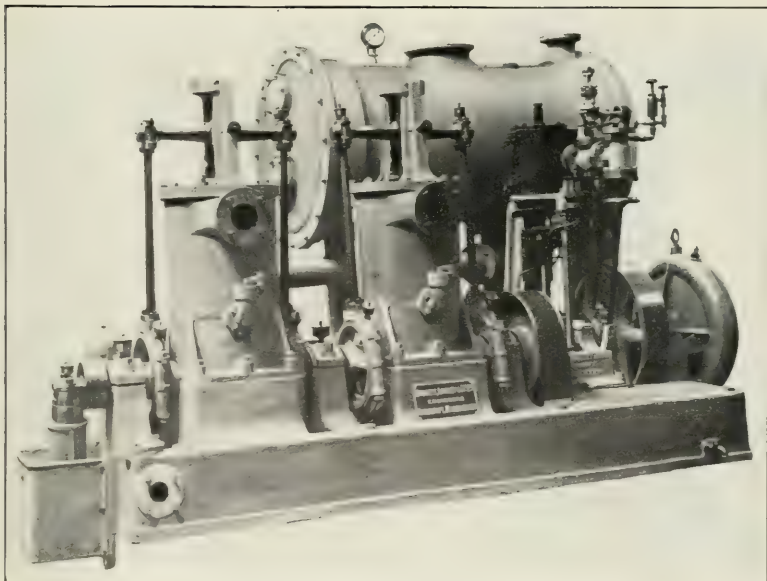
COMBINATION AIR AND CIRCULATING PUMP, WITH SURFACE CONDENSER.

6 and 10 by 12 inch. Worthington Pumping Engine Co.

below or behind. The cuts on pages 65, 66, 67 and 68 show types of these condensers manufactured respectively by The Blake & Knowles Steam-Pump Company, The Worthington Pumping-Engine Company, Messrs. Browett, Lindley & Co., and Messrs. W. H. Allen, Son & Co.

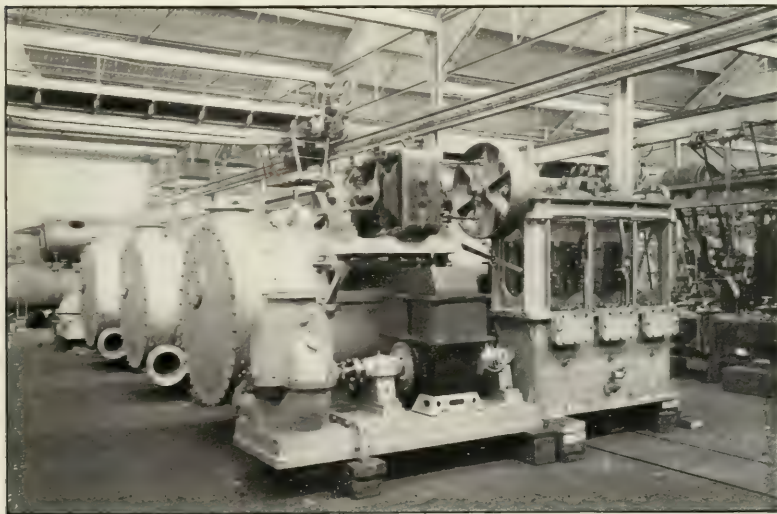
Condensers of this type are made in as small units as may be desired. Such condensers are compact and self-contained, and may be arranged to take the steam from all the engines, but they are particularly valuable as independent condensers coupled up to engines that for the most part of the day are not running.

Cooling Towers.—A surface or jet condenser cannot be installed, where water is scarce or expensive, unless a cooling tower be provided, and it is the introduction of such towers that has made it possible for a number of large plants to condense. The principle involved, of cooling water through towers or other medium, involves more than one process; as the water to be cooled passes over the



SURFACE CONDENSER WITH CIRCULATING PUMP.

10,000 lbs. steam per hour; three 150 horse-power engines. Browett, Lindley & Co., Ltd.

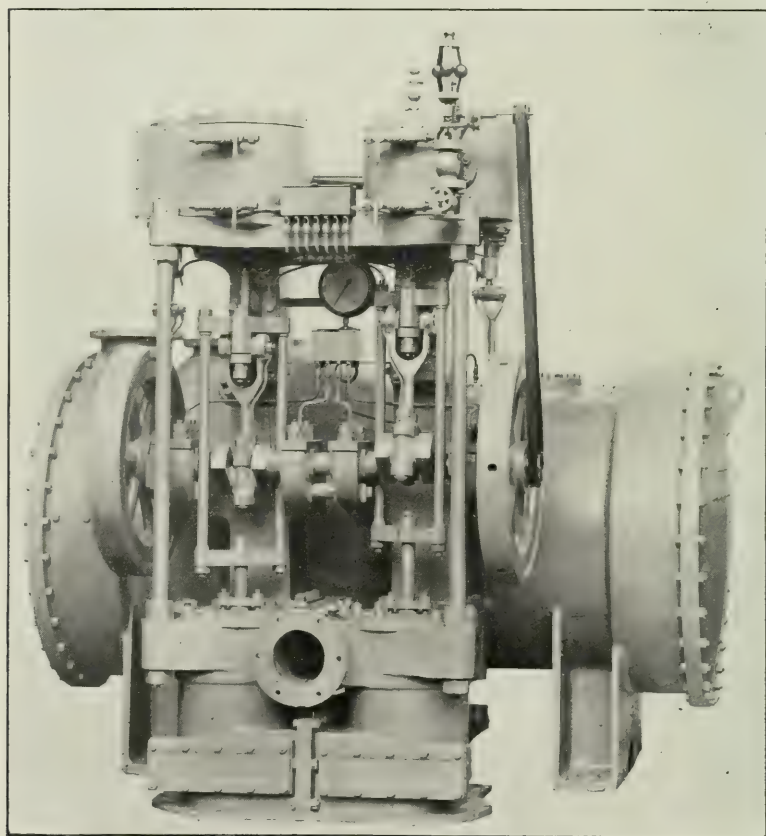


CENTRAL CONDENSING PLANT, GLASGOW.

15,000 lbs. steam per hour; 12 by 10 three-throw Edwards air pump, 11-inch centrifugal circulating pump, 1,500 square feet condensing surface. Messrs. W. H. Allen, Son & Co.

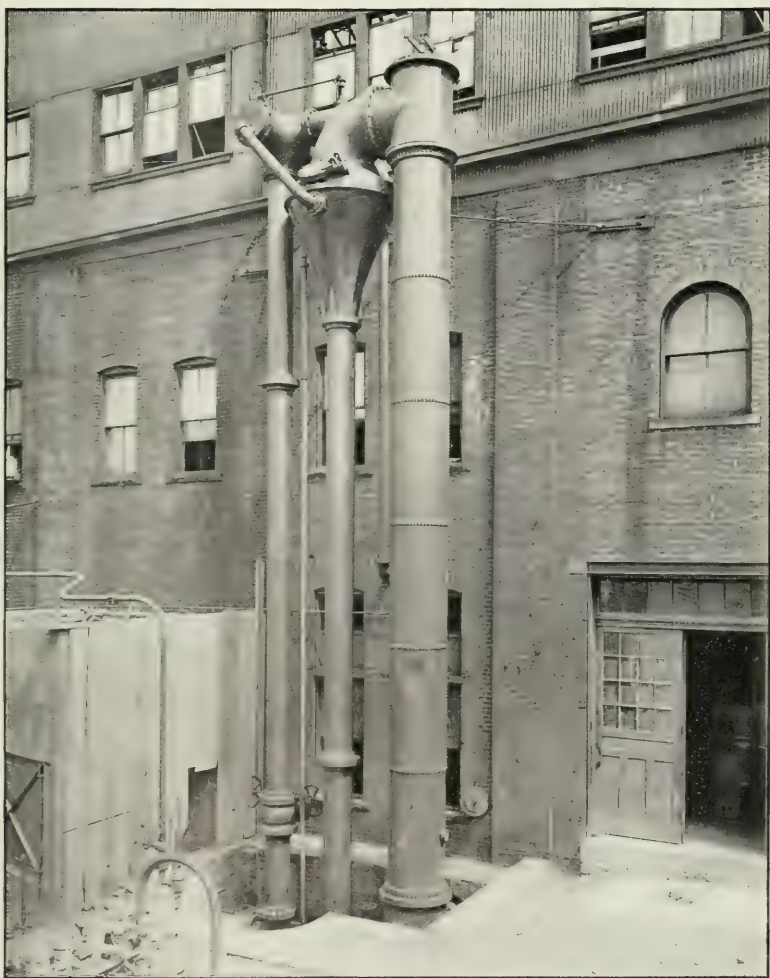
tower it is brought into contact with large surfaces of wood, galvanised-wire meshes, earthenware tiles, or other material.

In the first case a part of the heat is removed from the water by radiation and conduction through the sides of the apparatus. A further portion is carried away by the current of cold air passing through the apparatus; heat is also taken up by this incoming air. A far greater proportion of the heat is removed, however, by the evaporation of the circulating water, for by every pound of this water evaporated a thousand units of heat are carried off, and at the temperature we have to deal with in condensers it is equal to the condensation of one pound of steam. There is a loss, therefore, in the circulating water, due to this evaporation, which amounts to about 75 per cent.



SURFACE CONDENSER WITH CIRCULATING PUMP.

16,000 lbs. steam per hour, 6 and 12 by 6 inch engine, 14 by 6 twin air pump. 150 revolutions per minute. W. H. Allen, Son & Co.



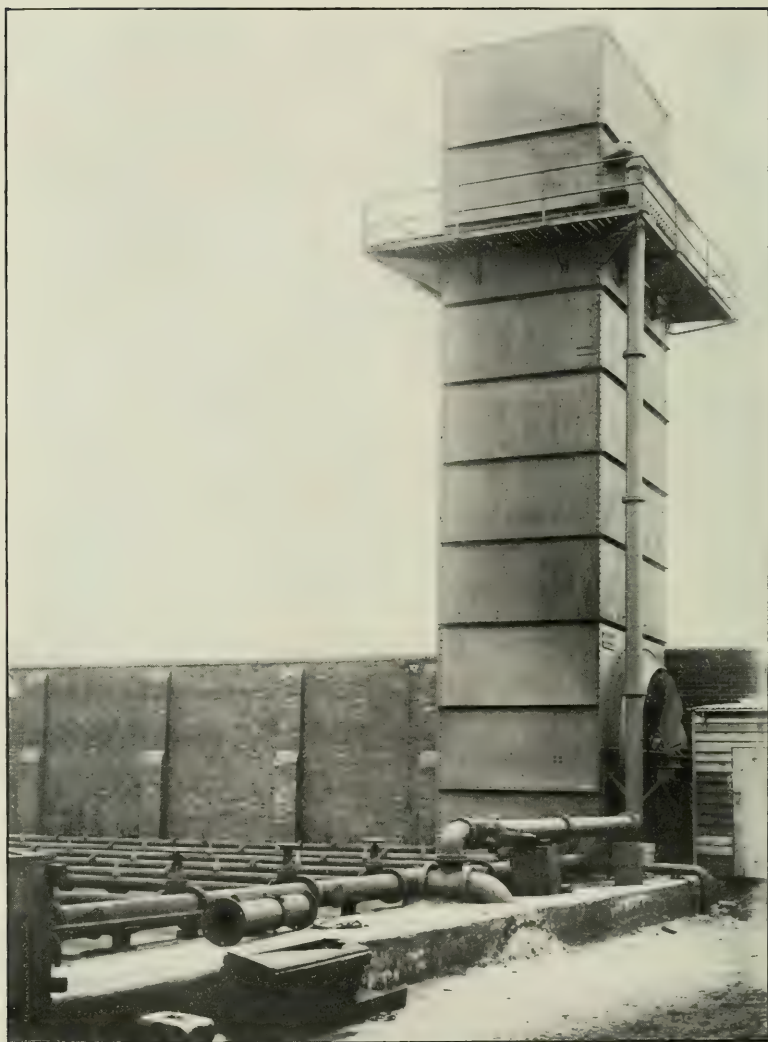
CENTRAL CONDENSER, WEST END TRACTION CO., PITTSBURG, PA.

Capacity about 60,000 lbs. steam per hour; injection water supplied by two compound vertical circulating pumps located in a pit on the river bank some distance away.

Henry R. Worthington, N. Y.

to 90 per cent. of the boiler feed. Under special conditions this loss may be reduced, as in the case of a test by Professor Burstall, at Mason College, Birmingham, with a Worthington tower, when the loss by evaporation was only 58.3 per cent. of the feed water. In this case the air temperature was 51 degrees F., and there was a difference of $3\frac{1}{2}$ per cent. between the wet and dry-bulb thermometers.

The space occupied by cooling towers varies according to the de-

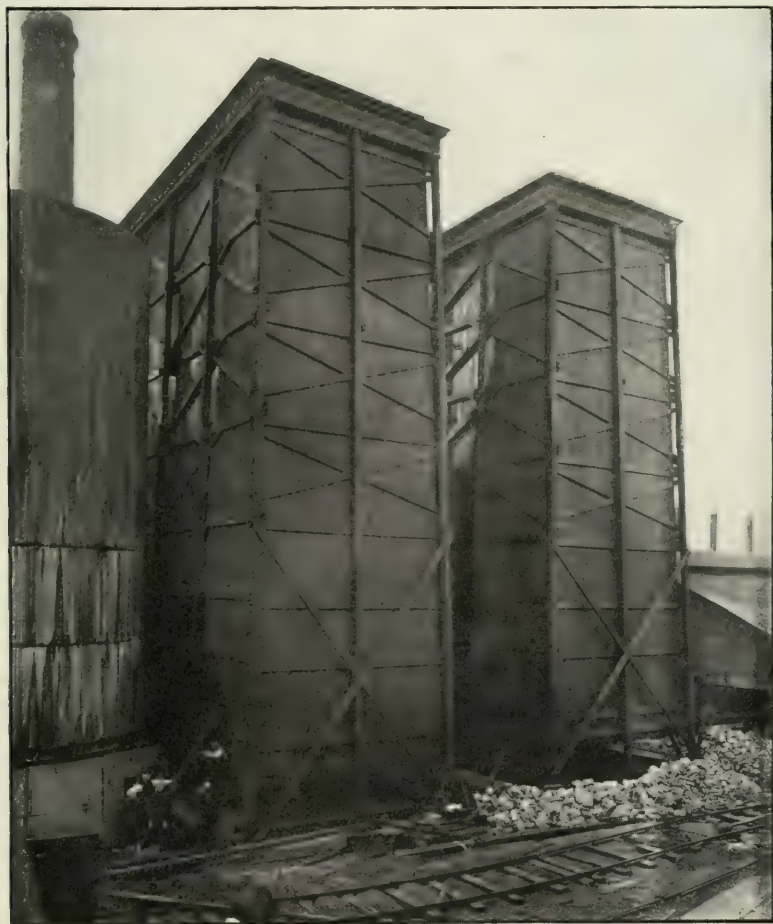


BARNARD WATER-COOLING TOWER OPERATING AT CROYDON, ENGLAND.
Wheeler Condenser & Engineering Co.

sign. Those with artificial cooling devices take up one square foot per 8 to 12 horse power, while those that depend on natural draught or exposure to the atmosphere occupy a rather larger ground space. The height of the towers varies, but generally within the limits of 30 to 36 feet (for the ground space mentioned), this height being that to which the circulating water is pumped. Where large ground space

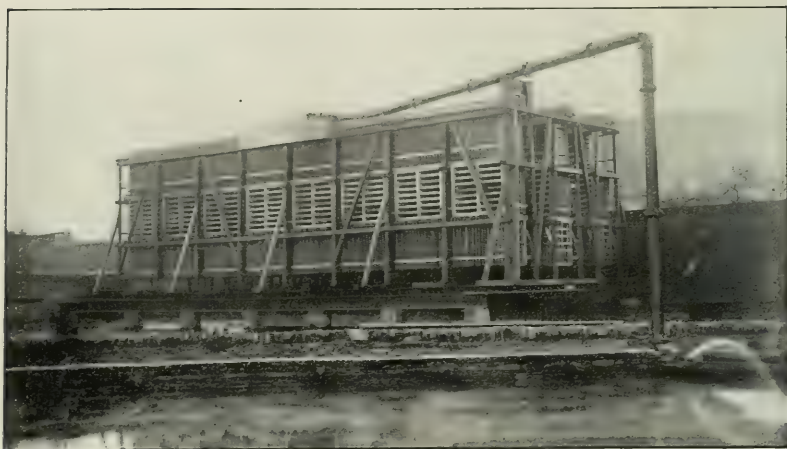
is available this height is reduced. These conditions vary considerably, however; it is necessary to provide sufficient cooling surface, and where the ground space is small the height of the tower must be increased; a lower tower would therefore occupy more ground space.

The power required to drive the fans would be from 1 per cent. to 2 per cent. of the total engine power. The circulating pump would require about the same power, making a total of, say, 3 to 4 per cent. for fan and circulating pump.



NATURAL-DRAUGHT CHIMNEY WATER COOLERS, CITY & SOUTH LONDON RAILWAY COMPANY'S GENERATING STATION, CLAPHAM, LONDON.

Dealing with the condensation water for engines of 2,900 indicated horse power. Klein Engineering Co., Ltd.



OPEN TYPE WATER COOLER, MIDLAND MILLS OF MESSRS. JEREMIAH AMBLER & SONS, BRADFORD, ENGLAND.

Deals with condensation water from engines of 800 indicated horse power. Klein Engineering Co., Ltd.

Their cost approximates from 20s. to 30s. per indicated horse power; this, however, varies considerably, according to conditions. Well-designed cooling towers reduce the temperature of the cooling water from an initial temperature of 130 degrees to about 80 degrees F., this temperature maintaining a vacuum of about 26 inches of mercury. When such results are obtained the temperature of the atmosphere would be about 75 degrees F., the humidity not exceeding 85 per cent. Atmospheric conditions decide at what speed the fans should be run. In winter, when the outside temperature is low, the fans need not be run at all for a partial load. Under general conditions, when the load is only one-half to three-quarters of the maximum, the fans may shut down. Provision should be made to vary the speed of the fans.

The accompanying illustrations will give an idea of the general form and arrangement of some of the leading makes of cooling tower. My succeeding article will deal specifically with their working principles, and will conclude with a discussion of the evaporative condenser and its auxiliary appliances.

THE COMMERCIAL ORGANIZATION OF THE MACHINE-SHOP.

By Hugo Diemer.

V.—PRACTICAL AND ACCURATE TIME-KEEPING.

ONE of the most certain signs of good management in a shop is the promptness with which every tool is started to do actual work. Such promptness is insured only by close supervision, particularly at the beginning and closing periods of working-time. Any laxity of foremen during these periods is very likely to have a contagious influence on the men. The mere ringing up or registering on time of the men by no means guarantees that every one of them is at work. The practice of having a preparatory signal three or five minutes in advance of beginning-time, mornings and afternoons, may also be profitably applied to the closing periods at noon and evening. If the workmen are given three or five minutes in which to close operations, the shutting-down will be far less hasty than where but a single closing signal is given.

Of automatic time recorders, the type operated by a swinging lever appears to be meeting with much favor. The registering can be accomplished a little more rapidly than with the key-type recorder and the workman does not need to carry a key with him.

It is customary in some shops to have a factory watchman stationed at the time recorders to see that each man registers only for himself. This is apt to create the impression that the management feels that the men need to be watched. A perfect check may be obtained on each man's time in other and inoffensive ways.

One of the best organized American shops does not use the automatic time recorders, but has a check-board for each section, on which the men hang their checks as they come in. The board is so mounted that it can be swung about a vertical axis. At the final starting signal the board is swung around with its back toward the shop, and as the section foremen's offices are enclosed by wire netting the check-hooks

Prof. Diemer's papers began with the issue of *THE ENGINEERING MAGAZINE* for June, 1900. The preceding articles have been :

The Systematized Classification of Shop Orders.

The Production Department: Bills of Material.

The Production Department: Store-Room Management.

The Production Department: The Execution of the Work.

are out of reach. The watchman at the general entrance does not require workmen with whom he is acquainted to show their checks unless they are late.

If a man is late and does not have his check with him, it suggests the possibility of some one else having hung up his check, and the matter is reported to the section foreman for investigation. The placing of check boards in the various sections does away with the crowding of men about the main entrance, which is apt to result if three or four time recorders are placed directly at the entrance.

In assigning check numbers it is a good plan to allot a certain number of men to each section or department, liberal allowance being made for growth of the shop, so that a rearrangement need not occur for a long time. Where automatic time recorders are used, such an allowance for growth may require at the outset an additional time recorder, but this original expense may be considered offset by the fact that the additional time recorder accomplishes a little more promptness in registering each day.

The time and cost clerks soon become familiar with the check numbers in the various sections, and if it happens that a vague or incorrect entry of time slips through the shop unnoticed, the workman and the nature of work he is doing are determined by his check number.

The workman's posting of the numbers of orders or sub-orders on which work is done is best examined by the section foreman or his clerk. Where possible it is best to obtain this approval every time work is changed from one order or sub-order to another. In some factories a separate time ticket is issued every time the workman changes from one order to another. This plan has the advantage that all the tickets covering any one order may be fastened together, so that the total time on any sub-order may be obtained from the tickets when the order is complete without any intermediate posting into a book. Where the sub-order system is used, however, and a form employed similar to that illustrated in Paper No. IV. of this series,* the sub-order copies sent to the time-keeping department take the place of the individual time tickets for each change of order, the time for cost purposes on individual sub-orders being posted on the back of the sub-order from the single daily time ticket made out by each man.

With this system a single daily time ticket was used, the form accompanying showing its make-up:

* THE ENGINEERING MAGAZINE, September, 1900, page 894.

The original object of the sub-order system had been to classify all similar work so that it would be more likely to be done together, and also to determine premium rates.

Having only these two aims in view, time entries were made on such sub-orders only as covered pieces on which premium rates were paid. The general cost-keeping system was continued the same as before the introduction of the sub-order system, namely, by recording total costs for entire general shop orders under certain general headings. In the case of a dynamo, these headings were as follows: Armature Core, Commutator, Armature Coils, Armature Connecting, Series Fields, Shunt Fields, Brushholders and Rockers, Yoke, Base, Assembling, Painting, Testing, Boxing, and in the case of special machines, Patterns, Drawings, and Tools. The foreman of each section had a list of these general headings, and all time was posted under one or another of these headings. When orders were completed, the cost of labor under each heading was compared with previous costs under similar headings for similar machines, and if much variation existed the matter was investigated. As this frequently involved a careful investigation of old time tickets, it is my opinion that it would have been best to post all time from the daily time tickets onto the time-keeping department's carbon copies of all sub-orders, instead of on such only as covered premium-rate work. The sub-order copies would thus serve as the sole cost record, the general book with records by headings being done away with altogether. The sub-order copies would be grouped under distinct headings, just as the time entries in the book had been grouped.

In this scheme, four distinct postings were made from the daily time tickets, viz.: (1) The pay-roll record; (2) The checking against foremen's estimates of time required to do the work; (3) The total-cost book record; (4) The record of individual sub-orders for determining premium rates. The last two entries could be merged together, as suggested above.

For keeping pay-roll records it has frequently been found very satisfactory to use a weekly card, instead of a book, for each employee. The card system has the advantage that any particular man's record may be taken out and examined or laid aside without interfering with the posting. The cards may be conveniently arranged according to check numbers. A form for card for pay-roll record is given on the opposite page.

The pay-roll clerk should also have a double set of permanent-record cards giving the history of each man, one set being that of

present employees, arranged according to check numbers, and the other being an alphabetically arranged set of all men ever employed by the establishment.

WEEKLY PAY-ROLL RECORD.					
Week beginning.....				Check No.....	
	Straight Time.		Overtime.		Premiums.
	Hrs.	Min.	Hrs.	Min.	
Monday....					
Tuesday....					
Wednesday..					
Thursday...					
Friday.....					
Saturday....					
Total.....					Total.....

Straight Time.....	hours, at.....	
Sunday Time.....	hours, at.....	
Overtime.....	hours, at.....	
Premiums.....		
Total		

The numerically arranged set of present employees need contain nothing further than the man's name and rate, date employed, and date at which he left, its aim being merely to identify men and rates corresponding to certain check numbers. A convenient form for the alphabetical or permanent-record card is as follows:

Name.....	Check No.....
Boarding or Rooming Address.....	
Home Address.....	
Application No.....	
Began Work.....	
Wages.....	
Increase, if any.....	
Stopped Work.....	Why.....
Foreman's Report.....	

It is of considerable importance to have such a record as indicated above. It makes a valuable record for answering inquiries or giving

testimonials to men, or in re-engaging them, and prevents new foremen from employing men who have been previously troublesome. The "Application No." refers to a file of applications which should be made in writing by every applicant for work. The item "Foreman's Report" refers to the foreman's statement as to the quality of work done by the man, this being usually filled out at the time an employee leaves.

As employees leave, there will be formed a gradually accumulating set of numerically arranged cards, which will be very useful when it becomes necessary to close up orders that have been in the shop for a year or more. With such a set of cards, the calculating of total costs from old postings of time is a simple matter, as the current numerical index shows just when the present employee holding a certain check number was engaged. If the work on any order ante-dates his engagement, the proper rate is obtained by reference to the numerically arranged card index of previous employees.

An instance has come to my notice in which, owing to lack of any systematic method of keeping such records of rates of former employees, the daily entries were made into the total cost record by dollars and cents instead of by hours and minutes. This not only necessitated a multiplication of the time by the rate for each entry, but it also brought about the result that if the armature of commutator of a certain machine showed excessive cost, the record of itself did not show whether the excessive cost was due to the expenditure of an excessive amount of time on it or to the employment of high-priced labor, and the only way to get at the facts of the case was to go back through the files and look up the individual time tickets—a very tedious and unsatisfactory mode of proceeding.

The form of bill of material illustrated in previous papers of this series* provides columns at the extreme right of the sheets into which the time-keeping department inserts the costs of labor. Where no record was kept of the individual sub-orders, the total time and its cost were posted in the bill of material under each general heading, such as armature core, commutator, etc.

It will have been noticed that in the form suggested for workman's daily time ticket an item "Tool No. . . ." appears. In any complete system of cost figuring consideration must be given to the relative expense of operating certain tools. Let us consider a large establishment equipped for the manufacture of both heavy and light machinery. Suppose this establishment has a total expense factor of 250

* THE ENGINEERING MAGAZINE, July, 1900, pages 515, 516.

per cent. of its productive labor. Another shop is equipped for the manufacture of light machinery only, and its expense factor is 150 per cent. The management of the larger shop looks at its total costs, derived by adding 250 per cent. to cost of labor on all machines, both large and small, and concludes that for some reason it cannot profitably build small machines. The fact of the matter is that if the tools had the expense account properly distributed among them, it would be found that the large establishment could very likely afford to sell small machinery at the same price as the smaller factory, and that the factor on large machinery should be increased to something like 400 per cent. of cost of productive labor. The small machines are not to blame for the presence in the shop of great, heavy, power-consuming tools, and in figuring costs it is an injustice to the small machines to charge to their account factors not at all involved in their construction. The manifestly proper way to arrive at the expense factors is to determine carefully the relative costs of operating the various tools and establish a certain factor for each individual tool. Besides these individual factors, there will be a general-expense factor which must be added to the total cost, this general-expense factor of course not including the percentages which have been already added to individual tools.

In figuring pay-rolls and total costs considerable multiplication can be saved by preparing a table of various hours and fractions of hours for the particular rates current in any one establishment. The ordinary books for this purpose will be useful in preparing such a special form, but they are usually too voluminous to be serviceable.

In order that the management may be thoroughly conversant with fluctuations in wages and attendance it is essential that the pay-roll clerk make a weekly report covering these points. A form for such a report is given on the next page.

A comparison of these reports from week to week will show whether there is laxity in any particular section, whether it would be good policy to raise wages of certain classes of laborers, whether women and boys are desirable help, etc.

The records of the time required to complete orders in hand may be kept on large sheets of cross-section paper, a sheet being used for each section or factory department, a serviceable form being shown in the second form on page 80.

From the daily report of orders finished, balances are struck, and at the end of each week discrepancies are taken up with the foreman and a report made out showing the work still ahead in each section.

Section.	A	B	C	D	E	Totals.
No. of Men Employed.....						
No. of Women Employed.....						
No. of Boys Employed.....						
Average Rate per Hour, Men..						
Average Rate per Hour, Women						
Average Rate per Hour, Boys ..						
Men Late.....						
Women Late.....						
Boys Late.....						
Men Absent						
Women Absent						
Boys Absent						
Men Discharged.....						
Women Discharged						
Boys Discharged.....						
Men Voluntarily Leaving.....						
Women Voluntarily Leaving....						
Boys Voluntarily Leaving						

SECTION..... WORK IN HAND.				
Order No.....	5027	5028	5029	Etc.
Estimated Time	130	26	45	
DATE				
1.	20	16	4	
2.	20	4	11	
3	20		11	
Etc.				

The forms shown above have been found useful in certain shops. The devising of a system to fit a particular factory will necessarily require the exercise of some judgment and originality. The development of methods of time-keeping should be a matter of careful planning, and needs to be undertaken by a person possessing a wider knowledge of the business than the clerk employed to post the time. The work of time-keeping is so intimately connected with that of cost figuring that the rational head of the time-keeping department will in most establishments be the person in charge of the cost department.

THE THOUSAND-MILES AUTOMOBILE TRIALS.

By W. Worby Beaumont.

THE thousand-miles trials of automobiles carried out by the Automobile Club of Great Britain and Ireland last June will ever remain the most important event in the motor-vehicle world of the year 1900. About sixty thousand miles were run by the vehicles under observation, and it is as difficult to overestimate the value of the experience gained as it is to impart a notion of it to those not concerned.



ARRIVAL OF THE TWO GREYHOUNDS OF THE TRIAL, A16 AND A17, NEAR BATH.

A million is a number which is big enough to convey the idea that a few more make no difference, so when it is stated that the total number of the revolutions made by the road wheels of the competing vehicles in covering that 60,000 miles was about 40,000,000, it will be allowed that that was enough to show up any defects. The wheels and axles may, however, be said to be very simple parts, so it may be mentioned that the collective revolutions of the crankshafts of the engines of the vehicles were about 70,000,000, and this means that the pistons of those engines made from 210,000,000 to 216,000,000 strokes, and the admission and exhaust valves not less than about 200,000,000 millions of strokes, or openings and closings.

These as well as the gear wheels are vital parts, and it needs no argument to show that such enormous numbers of repeated wear-causing and strength-testing operations could not have been made with machines very unfit for their work, or without teaching many lessons which, when fully utilised by those manufacturers who are susceptible of instruction and capable of putting it into practice, must lead to far-reaching developments.

The vehicles entered for trial were divided into two sections, namely, those entered by manufacturers and those privately-owned and driven by the owners or their substitutes or servants.

These two sections were divided into four classes, based upon the selling price of the vehicles—

Class A.—Cars declared at a selling price of £200 or less.

Class B.—Cars declared at a selling price of more than £200, but not more than £300.

Class C.—Cars declared at a selling price of more than £300, and not more than £500.

Class D.—Cars declared at a selling price of more than £500.

Class E.—Motor Cycles.

(a) Tricycles.

(b) Tricycles or quadricycles for two persons or more.

Class F.—Vehicles for public service.

There was a further section for parts of cars, but under this section only one entry was made, namely, of "Clipper" tyres. Of eighty-three vehicles entered for the trial, sixty-five started from Hyde Park Corner; but several of these could hardly have been expected to get through the tour and trials, and one at least has shown that even the best organisation may be perverted to unscrupulous business uses. Of this number, thirty-nine are recognised officially as having gone through the 1,000 miles with complete records, and climbed all the hills except the Shap Fell, which was optional. Ten others, with more or less broken records, arrived, and were exhibited at the Crystal Palace Exhibition, which opened on the 14th May, making a total of forty-nine. Of this number also fourteen entered and ran through the speed trials in Welbeck Park. The hills included:

Taddington Hill, 13,320 feet long, rising 651 feet, with most of grade varying from 6 to 8 per cent.

Shap Fell, No. 1, 38,300 feet long, rising 840 feet, steepest part a grade of 6.5 per cent.

Shap Fell, No. 2, 7,338 feet long, rising 500 feet, steepest part a grade of 10 per cent.



THE START. CARS IN FILE AT OUTWARD CONTROL FROM LONDON, AT HOUNSLOW,
ON BATH ROAD.

Dunmail Rise, 9,040 feet long, rising 450 feet, steepest part 650 feet of 9 per cent. grade.

Birkhill, 10,500 feet long, rising 460 feet, steepest part 9 per cent. grade.

All the vehicles with three exceptions were propelled by gasoline or mineral spirit internal-combustion motors, chiefly of the Daimler and Dion-Daimler types. The exceptions were two steam cars with boilers heated with mineral spirit, namely, a Stanley "locomobile" with two seats; a Whitney car with four seats, and a Roots & Venables kerosene-motor car.

It has been pointed out that all the automobiles that went through these trials did so under conditions that were very different from those that would obtain in the ordinary service of any user. There was no compulsion as to speed, but every vehicle had to "get there" at the end of a certain number of hours, or be beaten in comparison with those



BAD FOR THE NEXT CAR.

At 7 raising the dust near St. Albans after a run of 1,100 miles. Taken from the back of the car at 36 miles an hour.

that did, or lose marks. Such a trial was, therefore, a competitive trial all the way, although anything like racing was deprecated, and stringent regulations were made for low speed through the towns and districts under "control."

The trials were endurance and hill speed tests; economy as to fuel and water was not made a condition simply because this was not necessary, and because observations and records could not be made without a staff of observers

which no club organisation could supply. Watching, measuring, and recording of the petrol and water and lubricating-oil consumption throughout all sorts of country, over about 1,100 miles of roads, by automobiles which were at the start over sixty in number, would have been much more expensive than useful. The cost of the fuel per person is unimportant in comparison with other costs, and is in no case the determining cost. Moreover, the club conducts, once a quarter, a hundred-mile hill and consumption test of any vehicles presented, and the results are published. From these the efficiency of many of the motors and their vehicles is known.

The total distance to be run was 1,050 miles, not including an optional separate hill-climbing test up Shap Fell. There was also an optional speed trial on the private roads of Welbeck Park, the property of the Duke of Portland; this added about 28 miles, including the distances run at speed, to the total travel of the fourteen vehicles entered. Several hundreds of the miles of road covered were of the average good surface of English roads, but there were at least two hundred of the very bad surfaces in and near towns and on some of the very hilly districts, which are still too common, and for which the whole country pays very dearly.

In the open country on good roads, and where no one was looking, some very high speeds were occasionally made, one or two cars reaching over 40 miles per hour; but the great value of the trials lies in the proof: 1, of the endurance of the vehicles and their mechanism; 2, in the proof of hill-climbing powers; 3, in the test of mechanical efficiency of the transmission gear; 4, in the proof of the endurance, capabilities and the possibilities of the smaller types of cars or voituresses; and 5, in the tests of wearing powers of pneumatic and other tyres.

The greater number of the cars were built on the Panhard & Levassor and on Benz lines, with Daimler and with Benz petrol motors, but nearly all well-trying types were represented, as the following descriptive list will show:

In class A, which may be called the voituress class, there were two Benz light "Ideal" cars, both driven by single cylinder 3 horse-power Benz engines, the one by two belts from motor shaft to chain pinion shaft and with small epicyclic gear inside one of the driven pulleys for the slow speed; the other by one belt from motor shaft to a pulley on a spindle in a box containing three-speed gear. The general construction and the arrangement of these cars are well known. They were numbers 1 and 2, and weighed 13.25 and 13 hundredweight with passengers respectively, and both were fitted with Conolly solid tyres, which stood remarkably well and gave no trouble. The mean actual power given off at the road wheels on the hill climbing trials was by No. 1, the belt drive, 1.53 horse-power, by No. 2 belt and gear drive, 18.9 horse-power; and the mechanical efficiency of the whole of the transmission gear was thus 0.51 and 0.61, respectively.



BENZ CAR NO. 2.

First prize in Section I., Class A

The locomobile or Stanley steam car, No. 5, weighing 9.25 hundredweight, with passengers, and of 3 horse-power (nominal), went through the trial, but every part of it except the frame was sorely tried under the heavy ordeal. The single-tube tyres gave a great deal of trouble, the boiler primed a good deal, owing to insufficient size, occasional impure water, and (it was stated) to the introduction of something other than water; axle adjustments were found to be wanting and all bearings and the connecting-rod ends were as much worn as they could be and yet struggle to a finish. The trial showed, however, just where the weak points were and that improvements could be easily made with a few pounds more weight of metal, which would not detract from the good points in the car and its hill-climbing capacity, which was good. The framework and undergear of this carriage are especially deserving of notice. The apparent extreme lightness and yet now obvious sufficiency in almost all particulars are very suggestive. Although the frame may be said to be cycle

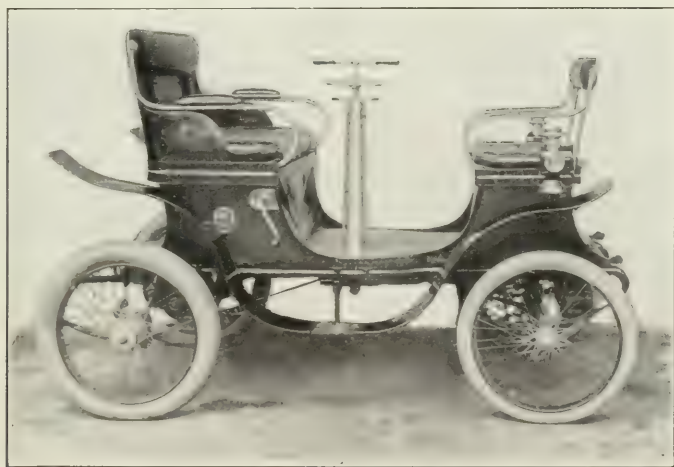


AT7. HON. C. S. ROLLS' 12 HORSE-POWER PANHARD, AND ATO. MR. KENNARD'S 3 HORSE-POWER NAPIER, ON THEIR RETURN TO ST. ALBANS.

Gold medal and first prize, respectively.

makers' work, it must be remembered that the design has to be schemed out before the cycle frame maker can get to work. The steam car has, however, against it the much larger consumption of petrol than by petrol motors; and, so long as it is without a condenser, the disadvantage of a stop about every hour and half or two hours for water. The average actual horse power shown by the hill

trials was 1.83, and the mechanical efficiency 0.61. The Gladiator voiturette, No. 16, is propelled by a small water-cooled motor of the de Dion type, nominally of 3 horse power, but obviously of much lower power. The motor drives by chain from the motor shaft to an intermediate shaft with epicyclic gear and clutches to give two speeds. A second chain from the shaft gives motion to differential gear on



3 HORSE POWER VOITURETTE OF DE DION & BOUTON.

Third prize, Section I., Class B.

the live axle at the back. The speed of this car was low on the hills, but high on the levels. With passengers it weighed 8 hundredweight, the maximum horse power shown at the driving wheels on any of the hills was 1.24, and the mechanical efficiency 41 per cent.; the mean horse power on the hills was, however, lower than this, and the mechanical efficiency correspondingly so. The transmission gear is on the whole simple, but the extra pull on the bearings, chain, and gear seemed to have added very materially to the resistances when the motor was doing its most on the hills.

Another type of vehicle was presented in the "New Orleans," No. 27, which has an air-cooled motor in the front, of nominally 3 horse power, de Dion type, and driving, by one long belt, simple two-speed gear of the planing-machine type on the main axle at the rear. This car weighed 8.5 hundredweight, with its two passengers, gave a maximum of 1.28 horse power at the wheels on one of the hills, and a mean of 1.07 horse power on the hills, mechanical efficiency of 0.425 and of 0.36 respectively. The performance of this

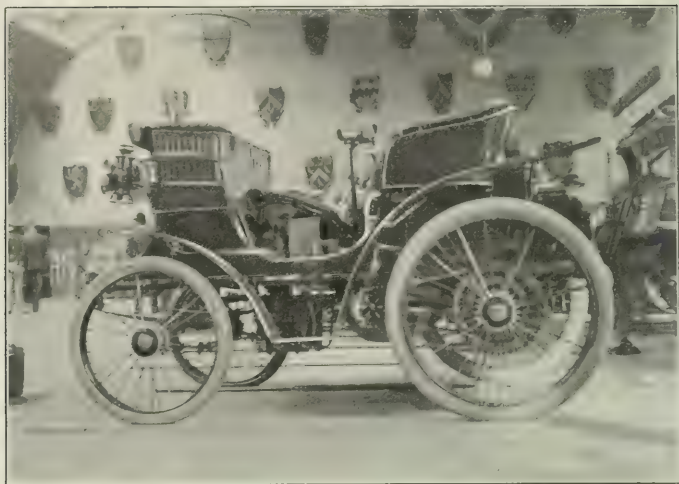


Fig. 29. MR. MAYHEW'S 7 HORSE-POWER PEUGEOT CAR, IN BRISTOL DRILL HALL.

light car was also very good, and it is a type which has already several sincere flatterers.

Two Decauville cars, Nos. 33 and 34, also went through the trials. These were driven by a pair of air-cooled motors of nominally 3.5 horse power at the rear of the vehicle, driving a live rear axle by bevel and spur gear, with shifting pinions for change of speed. The maximum horse power given by either of these at the road wheels was 1.23 and a mechanical efficiency of the better car 0.39, taking the mean hill performance; these cars weighed only 8.75 and 8.5 hundredweights respectively, including passengers. The more recent patterns of Decauville cars include several modifications which will improve them as to comfort, and make them less noisy.

No. 41 and 44 were two "International" Victorias. These are almost identical with the No. 1 Benz; that is to say, they drive by belt from motor to chain pinion shaft; their mechanical efficiency was 0.43 and 0.46 respectively.

The Star voiturette, No. 51, was another vehicle of precisely the same class. Its mechanical efficiency was 0.54, but it had several mishaps.

All the cars mentioned in the preceding Class A are separated from Class B only by price.

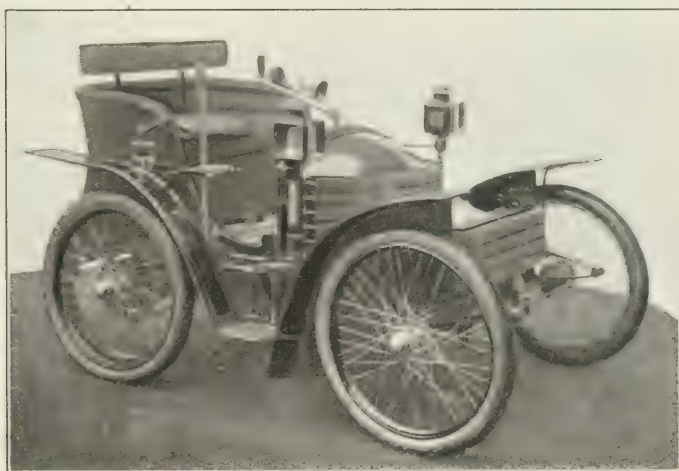
In Class B were two Marshall cars, which are practically the same as the Benz and Hurtu cars, but their performance was not as good.

Two Dion voiturettes, weighing $\frac{7}{2}$ hundredweight, or 9.5 hun-

dredweight, with passengers, went through the trials, and one of them showed a mechanical efficiency of 0.61 and a mean horse power of 1.84. These cars are driven by 3 horse-power water-cooled de Dion and Bouton motors through two-speed friction-clutch gear, the motion being transmitted to the rear driving wheels by jointed rods on the de Dion system. The motor and gear are carried by the car body, and the jointed rods referred to permit its rise and fall under the action of the springs.

Another car of this light type, Nos. 31 and 32, was the Renault, which weighs but 0.5 hundredweight, without passengers, or 9 hundredweight with passengers. It is driven by a 3 horse-power water-cooled de Dion motor under a bonnet in the front, driving through a cone clutch and change-speed gear of the lathe and mowing-machine types, this gear giving motion to a jointed rod running fore and aft of the carriage, and driving the live rear axle by bevel pinion and bevel wheel on the outside of the differential gear. One of the two Renault cars ran very well and at considerable speeds; the maximum power was 1.75 horse power and the mechanical efficiency reached 0.58. The frictional resistance of the transmission gear is thus smaller than that of several of the other light cars, but like several other voituresses it is noisy.

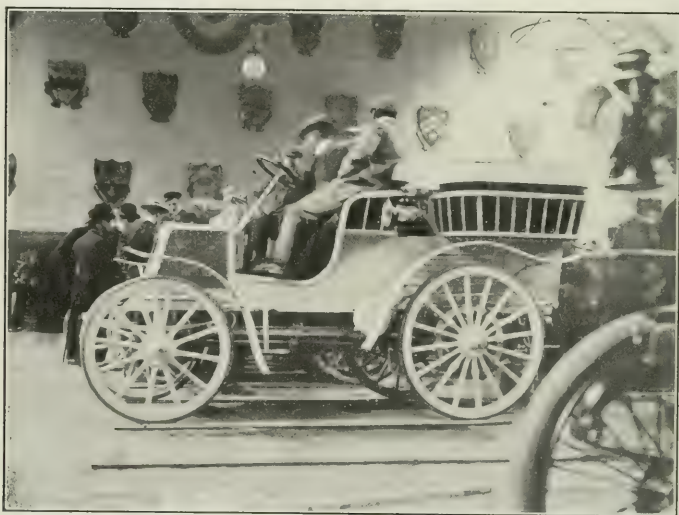
The car in this class of most originality was No. 40, namely, the Wolseley voituress. It is shown by the accompanying photograph. This car ran exceedingly well throughout the trials and on the hills. The motor was entered as of 3 brake horse power, but in the works



WOLSELEY VOITURETTE, NO. 40, SECTION I, CLASS B.

had given on the brake, when new, 3.3 horse power at normal speed of 700 revolutions per minute. On the trial, however, it was always run on the throttle valve and without doubt often ran at 900 revolutions per minute, which would bring the power up to at least 3.6 horse power. The mean effective horse power required at the road wheels on the Taddington hill trial was 2.83, when three passengers were carried. At this time a low gear was in use, and the engine running at not less than 800 revolutions per minute, giving 3.75 brake horse power, which, with 2.83 horse power at the road wheels, gives a mechanical efficiency of 0.75, which is extremely good.

Turning now to some of the heavier cars, we come to Class C, and here we have cars on the Panhard & Levassor and the Peugeot lines. A large number of these must be grouped together, namely, fourteen 6 horse-power Daimler motor vehicles, either of the Panhard or of English construction on Panhard lines, two forms of which are illustrated. Of these it is only necessary to say that their average performance was good, and that their mechanical efficiency is from 0.5 to 0.6. Some of them as made in Coventry are known as the Parisien Daimlers, and their running and hill-climbing was in every way satisfactory. They have more substantial gear than the similar Panhard cars, and, though high priced vehicles, are among the best yet made. The general arrangement of the gear is that



6 HORSE-POWER DAIMLER WAGONETTE, NO 36, LONG WHEEL BASE, IN BRISTOL DRILL HALL.
A First Prize.



A2, MR. BUTLER'S 6 HORSE-POWER PANHARD TONNEAU CAR IN BRISTOL DRILL HALL.
Silver Medal.

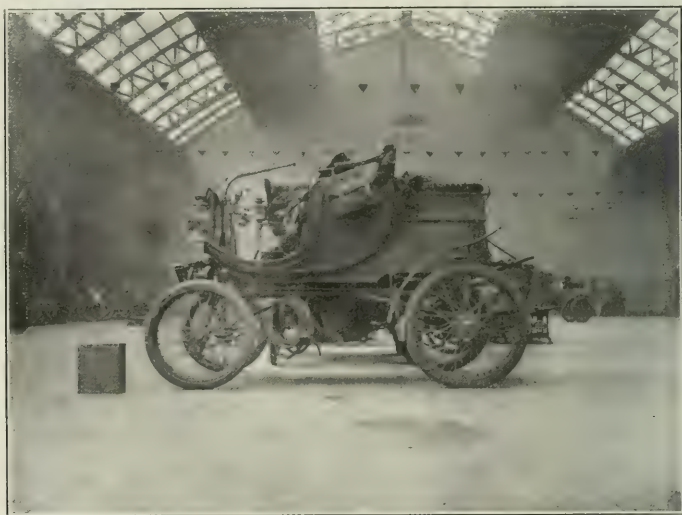
shown in *THE ENGINEERING MAGAZINE* for September, 1897, page 960; but great improvements have been made in every detail and in the motors. The spur wheels and pinions have been made wider, stronger and much more durable. The brakes have been made stronger, and one at least of them acts in both directions. The steering gear has been strengthened, and, being operated by worm and quadrant, is self locking. The motor gives more power for the same weight than formerly, and will run at any speed, by throttling, from about 300 to 1,200 revolutions per minute.

The Whitney four-seat steam car, No. 23, with chain drive to live rear axle, got through the trials with many instructive troubles which befell nearly everything but the framework. A Renold saw-tooth chain was used, and one of its links broke at a pin hole, stood up, and sawed a hole through the bottom of the water tank, which was too near. A different chain and more clearance will be used in future, and much greater accessibility of engine must be secured. Nuts came off one of the crankshaft bearings. The results are just as well imagined as described; the nuts will not be allowed to come off again. The tyres, which were very thick single-tube pneumatics, gave no trouble, and wore exceedingly well.

The Richard cars, Nos. 46 and 47, which have belt, gear, and chain drive, went very well indeed through the trials. They carried four passengers, including driver, and although the machinery is not so accessible as in some of the other cars, it seldom required the whole

of the time allowed for adjustments or repair at the stopping places. The total weight was about 21 hundredweight, or 16 hundredweight without passengers. Two passengers had to descend during part of the Dumrail Rise climb. The brakes are too slight, and will not act properly for a backward stop.

The Lanchester car, No. 22, went through the whole trial, but



WHITNEY STEAM CAR, NO. 23, IN THE DRILL HALL, SHEFFIELD.

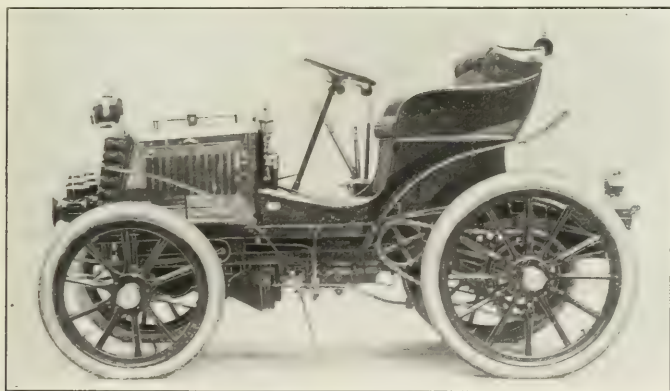
ignition difficulties gave trouble the last few days, causing considerable delay and preventing the appearance of the car at the stopping places on the last two days. This car has a two-cylinder 8 horse-power motor with two connecting rods to each piston. These rods work two cranks, geared together and running in opposite directions. On each crank is a fly wheel, one of which carries bar magnets for generating the ignition current, and the other carries fan blades for cooling the motor cylinders. One of the cranks is continued aft, and there, by means of two alternative clutches, drives a worm which gives motion to a worm wheel on the live driving axle. The object of the form of motor chosen (Patent No. 10,836, of 1898) is to secure balanced running at all speeds. For the trial a lower pitch of worm than had previously been used was fitted and the speed of the car reduced, and this may have contributed to the low efficiency of the gear, as shown by the hill-climbing, which was only about 0.32. As, however, the efficiency was only a little higher than this on the previous trials with the higher-pitch worm gear, it must be assumed that the efficiency of the transmission is not what was expected, that the

air-cooling fan takes much power, and that, as in other air-cooled cylinders of this size, the power falls off on a long, heavy pull.

Among the smaller comfortable two-seat voiturettes was the Mors Petit Duc of Mr. Phillips in Section II., No. A, 24. This car weighed with passengers 13.5 hundredweight, and is fitted with a 4 horse-power water-cooled double-cylinder motor placed transversely under a bonnet in the front; the crankshaft extending rearward drives a chain pinion shaft through three-speed gear. This car worked exceedingly well throughout the trials, the only stoppage of any note being due to an electrical defect which could have been remedied in one minute with more exact knowledge of the arrangement of the circuits. As in many other cars, there are details which may be easily improved, and this applies in particular to the governor gear; the efficiency of the car works out to about 0.54.

It is not necessary to describe other cars at length, but particular reference may be instructively made to the performance of two other vehicles, namely:

No. A10, the 8 horse-power Napier, driven by Mr. S. F. Edge; and No. A17, the 12 horse-power Panhard, of the Hon. C. S. Rolls, by whom the car was driven. Both these cars have an apparent



A17. HON. C. S. ROLLS' 12 HORSE-POWER PANHARD & LEVASSOR CAR. DICKEY SEAT REMOVED.

First prize in Section II., Class D.

efficiency of 0.82. This is based on the total weights and on the brake horse power entered by the owners. Both of these motors were, however, practically run without any governor, and their normal speed was very considerably exceeded. It will certainly be no exaggeration if a speed of 850 revolutions per minute be assumed as that which obtained on these hill trials, and it is possible that it was

more than this if the gear which could be used was a low one. Even allowing, however, for Mr. Rolls' remarkable skill in driving, and manipulating his speeds and mixture adjustments, it cannot be for one moment supposed that this skill and attention raises the mechanical efficiency of the transmission gear of his Panhard car to anything like 82 per cent. Nor can it be admitted that this has been reached with the 8 horse-power Napier-Daimler car. Indeed, the consideration of the speed trials confirms the supposition that the actual power of the motor was very largely increased by increase in the number of revolutions.

The measured mile on which these trials were run was by no means level, the gradient reaching in one place 1 in 26.1, and the total rise being 70.37 feet, or 1 in 72.5. The surface of the road was excellent, and there was no noticeable wind. Fourteen cars took part in the trials, with the results given in the following table:

WELBECK PARK TIME AND SPEED RECORDS.

No. of car.	Description.	Time uphill.	Time down hill.	Mean time.	Average miles per hour of mean time.	Average miles per hour of down- hill time.
		M. S.	M. S.	M. S.		
A17	12 H.P. Panhard, Hon. C. S. Rolls's...	1 46 ⁴ / ₅	1 24 ³ / ₅	1 35 ³ / ₅	37.63	42.55
A4	8 H.P. Panhard, Mr. Mark Mahew's...	2 17 ³ / ₅	1 45 ⁴ / ₅	2 1 ³ / ₅	29.60	34.02
A10	8 H.P. Napier, Mr. Kennard's.....	2 16	1 47 ³ / ₅	2 1 ³ / ₅	29.50	33.51
4	Ariel tricycle with Whippet trailer....	2 11 ¹ / ₅	1 53 ¹ / ₅	2 2 ³ / ₅	29.45	31.80
A22	12 H.P. Daimler, Mr. J. A. Holder's...	2 34	2 0 ² / ₅	2 17 ⁵ / ₅	26.23	29.90
A11	12 H.P. Daimler, Hon. J. Scott Montagu's	2 38 ¹ / ₅	1 57 ¹ / ₅	2 18	26.68	30.56
39	Century tandem tricycle.	2 31 ³ / ₅	2 24 ² / ₅	2 20 ² / ₅	24.09	24.93
16	3 H.P. Gladiator voiturette.....	2 48 ³ / ₅	2 22 ¹ / ₅	2 35 ⁵ / ₅	23.16	25.31
A31	6 H.P. Parisian Daimler, Mr. Johnson's	3 1 ³ / ₅	2 10 ³ / ₅	2 36	23.07	27.52
40	3 H.P. Wolseley voiturette	3 1 ¹ / ₅	2 14 ³ / ₅	2 37 ⁵ / ₅	22.81	26.74
14	3 H.P. De Dion voiturette.....	2 54 ⁵ / ₅	2 33 ⁴ / ₅	2 44	21.70	26.00
A3	6 H.P. Panhard, Mr. T. B. Brown.....	3 26	2 12	2 49 ¹ / ₅	21.27	27.19
A2	6 H.P. Panhard, Mr. Butler's.....	3 10 ¹ / ₅	2 28 ¹ / ₅	2 49 ⁵ / ₅	21.27	24.13
15	3 H.P. De Dion voiturette.....	3 22 ⁴ / ₅	2 47 ⁵ / ₅	3 5	19.45	21.53
—	7 H.P. Peugeot, Mr. Lord's.....	2 45	1 58 ¹ / ₅	2 21 ³ / ₅	26.97	30.45

All the above trials, with the exception of Nos. 4 and A 2, were made with driver only on board.

From this table it will be seen that four vehicles ran at considerably over 31 miles per hour on the down grade, and nearly 30 miles per hour mean speed up and down grade; while Mr. Rolls' car reached 42.55 miles per hour down hill, and 37.63 as the mean of the up and down grade.

Now the actual work done in propelling this car at the mean

speed of 37.63 miles per hour is only 4.46 horse power, while the air resistance at that speed equals 8.06 horse power, making a total of 12.52 horse power. In estimating the air resistance, head resistance only being considered, the head wind area is taken as 15 square feet, which is as near the area as can be ascertained. Assuming an efficiency 0.75 or 75 per cent. for the transmission gear, the actual power of the motor was 16.7 horse power. This being the case, the motor speed must have been increased from the normal of 750 per minute to at least 1,040 per minute. On the hill trials, therefore, Mr. Rolls may have been using anything between 12 horse power and 16.7 horse power, depending partly upon the particular pair of speed gear wheels he was able to use. Thus, assuming that he was able to use a low gear and a high speed of motor, and thus get, say, 15 horse power out of the latter, the true mechanical efficiency of the transmission gear would be 65.5. It is thus obvious that, unless the hill-



MR. HARMSWORTH'S 12 HORSE-POWER PANTHARD CAR, 1900 PATTERN, AT CALCOT PARK.

climbing trials were conducted with a known speed of motor, the true mechanical efficiency cannot be obtained.

The 8 horse-power Napier car of Mr. Kennard, which is fitted with a Daimler motor with slight modifications, and was driven by Mr. S. F. Edge, had an apparent mechanical efficiency exactly the same as that of Mr. Rolls' car, namely, 0.82, or 82 per cent., and the speed trial gives an efficiency of 87.8 per cent. if the motor be taken as only of the power stated. Of the total power accurately used, 3.58 horse power represents the net work of propelling the car at the

speed observed, and 3.43 horse power the work done against air resistance, or a total of 7.01 horse power, the head area being in this case taken as 14 square feet, instead of 15 as in the case of Mr. Rolls' car. The motor was probably running at about 1,000 revolutions per minute and giving about 10 horse power.

Considering the general excellence of the machinery of Mr. Kenard's car and its performance on the hills, it might have been expected that it would have given a higher speed on the Welbeck Park road; but as the motor was driven throughout the tour without a governor, it may be said to have been "accelerated" during the whole



A31. 6 HORSE-POWER "PARISIEN" DAIMLER, IN BOTANICAL GARDENS, MANCHESTER, Silver Medal.

of the running, and there was little to call upon when the higher speed of rotation was required.

The same remarks obtain with regard to the Wolseley car, which was run during a great part of the tour on the throttle, and not with a governor. On the speed trial the tractive work was 1.75 horse power and the air-resistance work 1.18 horse power, with a head area of 10 square feet, giving a total of 2.95 horse power. Thus, assuming a mechanical efficiency of 0.75, the motor was obviously capable of giving 3.92 horse power, and this would give a true mechanical efficiency of 68.5 per cent. This is high, and is about what might be expected from the car. It is unnecessary to follow out this examination to more of the cars, but the generally excellent behaviour of some of the 6 horse-power Daimler Parisien cars makes it desirable

to refer to them. Taking one of them, A31, which made a mean speed of 23.07 miles per hour, and a speed of 27.52 miles per hour on the down grade, it will be noticed that the difference in the uphill and downhill speeds was greater than with the previously mentioned cars. This car, having a 6 horse-power motor, weighed with passengers 2.45 hundredweight, while the Panhard, with its 12 horse-power motor, weighed but 20.25 hundredweight. Hence the weight of the car with the 6 horse-power motor tells heavily against it on the uphill, and gives an apparent disproportion between the uphill and downhill speeds, which would not of course be found with the 12 horse-power car. This is apparently not in agreement with the figures obtained with the 12 horse-power English Daimler cars; but in one at least of these cars, namely, Mr. Holder's, the weight is excessive, and the motor was only giving on the speed trial 8.4 horse power, assuming 75 per cent. efficiency of transmission. On the other hand, with Mr. Johnson's 6 horse-power car, the tractive work was 2.54 horse power, air-resistance work 1.68 horse power, or a total of 4.22 horse power. With similar performance Mr. Holder's motor should have given 11.2 horse power, Mr. Johnson's motor giving 5.62 horse power for the 4.22 horse power at the wheels.

One of the noteworthy results of the great trial is the confirmation that it affords of the continuous working capacity of the little high-speed motor which so many engineers and others not acquainted with its performance under severe conditions seem to think is the vulnerable part of a motor carriage. It may safely be said that, on the whole, the motor itself may be depended upon to give less trouble than any other part of the car machinery. There are, no doubt, many motors in which slight modifications of the lighter parts, which are too light and have insufficient size and strength in joints and pins, will reduce the number of stoppages for slight adjustments and for repairs. These, however, the experience now obtained will make easy. That "it is the pace that kills" has been once more proved by these trials. The old adage must, however, be used with qualifications when applied to the motor car. The effect of speed and weight together is as certain with regard to the automobile as with the horse, but the horse cannot escape the effect of speed and continuation of effort though he may be bred for speed. The motor vehicle can, however, escape this to the extent that continuation of effort has no more serious effects than consumption of fuel and wear of renewable parts. When, however, the attempt is made to run the motor equivalent to the heavy horse at the speed of the light one, then

the limit of endurance of the renewable materials is so rapidly reached that cost precludes commercial practicability. The lighter forms of motor vehicles may run at double or treble the speed which a carriage horse can maintain, and do so almost continuously for the number of hours per week that any driver would care to travel. On the lighter cars good pneumatic tyres were little or no trouble throughout the tour, and they returned in good condition, one of the two elements necessary to the destruction of the rubber, namely, weight or pressure, being absent. On the other hand, even the best tyres on the heavy cars suffered severely, and experience showed that the cost of fuel per mile run was not more than from one-fifth to one-half the cost of the tyres. It is, therefore, only half the truth to say of motor cars that it is the pace that kills; for, so far as tyres at least are concerned, it may equally be said that it is the weight that kills. The limit to weight which rubber can carry, without easy destruction at common speeds, has already been reached, both with pneumatic and with solid tyres; but the limit to improvements which will reduce weight is at present far off, and high speed for other than mere racing purposes need not be always prohibited on the ground of cost of tyres. The very slight wear of the solid tyre of the Benz cars, after nearly 1,100 miles' running, was very remarkable; it proved that moderate speeds and light weight had very little effect on the rubber used; on the other hand, some of the solid tyres on the heavier cars, though wider in proportion to weight, were not only severely cut and worn, but were very much deformed and loosened in the part held in the rim.

In a good many instances a very objectionable exhaust was given off by cars in which it is known that the combustion is generally very good. In some of these cars this was due, no doubt, to improper adjustment of air and petrol; but in several instances it was due to the unsatisfactory character of the lubricating-oil adjustment and admission. There can be no doubt that a mechanical lubricator which acts only when the motor is running would prevent the frequent recurrence of this objectionable exhaust, doubly objectionable because it is always worst immediately after starting, which is generally done before a crowd of spectators.

It is somewhat remarkable that, after all the experience which makers have had with the pumps for circulating the cooling water, so many troubles and failures should still occur with this detail. There ought to be no difficulty whatever in making and applying a suitable pump for this job which would run continuously, if necessary, for a whole year.

EDITORIAL COMMENT

The hugeness of the wreck at Galveston can hardly yet be fully seen, but, unlike most disasters, it seems to have been minimised in the earlier reports, and to make the losses and sufferings of war appear small by contrast. It is yet too soon to forecast accurately its future influence, or to draw inferences, except, perhaps, that ordinary protection and ordinary structures are insufficient to withstand the forces of ruin which may attack a city built only a few feet above the sea and within the hurricane zone. The storm, however, seems to have been entirely without precedent, so far as recorded observations go, and, as one commentator remarks, "there has been but one Lisbon earthquake."

It is not unnatural that some despondent authorities should consider the ruin final; on the other hand, the general determination seems to be to raise the city up again, more powerful and prosperous than ever, and secure for all time against even such fury as that of the late storm. A great deal depends on the action of the Southern Pacific Railway. It has generally been believed that Mr. Huntington was pushing Galveston developments against the opposition of most of his directors. The present executive head of the road, however, asserts that they will certainly rebuild. Geographical and economic conditions indicate Galveston as the great port of the southwest. The sympathy and backing of the United States are behind her. We venture to predict that she will recover as Chicago did from the fire, Charleston from the earthquake, or St. Louis from the tornado.

* * *

Coincident with the new and important movement toward the export of American coal—a movement whose meaning and

value to the old world and the new is clearly shown in our leading article this month—comes the menace of a coal strike which, by the estimates of the labour leaders themselves, will be "the most serious and disastrous episode in the history of the American coal industry."

It is true that the movement so far is confined to the anthracite field, which is not directly concerned in the rising export business; but to an appreciable extent the anthracite and bituminous fuels are competitive in the States, and the soft-coal market cannot fail to be importantly affected by difficulties in the hard-coal trade. It is a deplorable event for manufacturing, engineering, and commercial interests everywhere—the more so as the consensus of outside opinion seems to be that the strike is inexcusable. It centres apparently on the old question of "recognition of the union." The relations of operators and workmen generally are said to be good, work abundant, and wages satisfactory. The stated grievances are the "company store" and the price of powder—the latter a chronic one; it has been the custom to charge the men an arbitrary price for powder, but this has been offset by higher wages. The practice is a bad one, as the men see and object to the direct charge, and do not recognise the indirect offset. The operators aver, however, that no grievances have been presented to them by their workmen, but that demands are made upon them by the United Mine Workers, an outside organisation seeking to control both employees and employers. The struggle apparently can bring only distress and suffering to the men, loss to the operators, and injury to industry everywhere. It is deplorable that no means were found to avert it.

The working world must awaken to a controlling knowledge of the utter wastefulness of war. Mr. Skelton, elsewhere in this number, speaks of the "periodical irruptions of hostile feet" which have so often and so painfully crushed the industrial rise of the European continent. The worst wreck of all is that caused by the trampling of fighting factions within the social fabric of the nation. After the lessons of the British engineering strike, the lately-threatened American machinists' strike, and the evident efficacy of reason and arbitration as displayed in other great trades, a strike like this is a folly and a crime.

* * *

The exhaustive discussion by Mr. Maynard, in the August issue of *THE ENGINEERING MAGAZINE*, upon the relative cost of horse and mechanical traction upon common roads, has brought attention to the very interesting examination of the same subject made by Oliver Evans so long ago as 1804.

We are indebted to Mr. Henry G. Morris, of Philadelphia, well known in connection with the development of electrically propelled vehicles, for a copy of the proposal made by Oliver Evans to the Lancaster Turnpike Road Company, advocating the introduction of the steam wagon which he had already made.

This interesting document, which we have not space to reproduce in full, gives a detailed estimate of the cost of horse wagons and equipment equal in capacity to the steam wagon, the general comparison being as follows:

Steam wagon capable of carrying 100 barrels of flour at a rate of three miles an hour on level roads, or, on the average, forty miles in twenty-four hours, is put at \$2,500, while the cost of five horse wagons and equipment of equal total capacity foots up \$3,304.15, a difference in favor of the steam wagon of more than \$800 in first cost.

In regard to operating expenses, Evans shows that the cost of one journey from Philadelphia to Columbia, made in two days by the steam wagon, would be

twenty-one dollars, while the same journey would require three days for the horse wagons, at a total cost of forty dollars. The cost of repairs he estimates as about the same for each wagon, say two dollars, and hence five times as much for the horse wagons as for the steam wagons.

Apart from the interest which attaches to an estimate of this nature made so very early in the history of steam traction, it is most curious to note, as Mr. Morris points out, that the figures of Oliver Evans in 1804 agree proportionately almost exactly with those determined by experience at the present time.

In general terms, given suitable roads, twice as much work can be done for the same cost with mechanical traction as with horse power. Evans was far ahead of his time in this matter as in some other, and it is a satisfaction at this time to be able to bring to notice his clear grasp of the subject.

* * *

In the days of upheaval of cities, and borings of tunnels, and general rearrangement of local transport, the announcement that Mr. Charles T. Yerkes is to enter the field in London with a new underground railway scheme is of both commercial and engineering interest.

The success of the London Central Railway has undoubtedly been the inspiration of this new move, and whatever the outcome, it cannot but attract attention and invite discussion. The name of Yerkes has hitherto been associated entirely with surface traction, and that, too, in America; but the success which has stamped his administration in Chicago gives assurance that, should the proposed scheme be undertaken in London, it will be carried through with energy to success.

Although it is too soon to discuss details of construction and methods of operation, it is sufficient to know that the name of Sir Douglas Fox is given as that of the engineer to warrant confidence in the construction work, while the fact that the electrical equipment and rolling stock will be American will not bring adverse comment.

Electrical Power Distribution.

THE consideration of the bills recently brought before the parliamentary commission presided over by Sir James Kitson, has called forth numerous communications to the scientific press, and among these one of the most noteworthy is that of Professor Ayrton, in a recent issue of *Nature*.

Twenty-one years ago Professor Ayrton himself used these prophetic words: "If a workman could have transmitted to him, just at the time he might require it, a small amount of energy at, say, one-half penny per hour per horse-power—which would be three or four times the actual cost of production with a very large steam engine—and if he could turn off the power like gas when he did not want it, how many of the smaller workmen of Sheffield would be glad to avail themselves of such a facility!"

To-day the question is not whether this is possible, but rather whether the men who are ready and desirous of providing just such a desired distribution of power are to be permitted to do it.

Professor Ayrton reviews at some length the testimony for and against the four important bills, namely, those for Durham, Tyneside, Lancashire, and South Wales, and while approving on the whole, of the plans for the generation and distribution of electricity in bulk, he shows that the municipalities are not wholly acting the part of the dog in the manger, but that in some cases their positions are worthily entitled to consideration.

On the question of the desirability of central generating stations and electric distribution of energy, he has no doubts whatever. After referring to the fact that most articles of commerce may be divided into those which have weight and volume, and those that have not, Professor Ayrton proceeds:

"But there remains one commodity which, although it has neither weight, volume, nor linear dimension, can be metered

with extreme accuracy, and the public demand for which is daily becoming greater and greater, and that is—energy. Hitherto the working of factories has been associated with water and coal, and either the factories have been built near the stream or in a coal region. When, however, such a site could not be conveniently found, then it has been the custom to carry at a dear rate a black, bulky, dirty substance, by rail or water, for miles to the factory, and, after strewing a certain portion of its dirt over the neighbourhood in the form of a descending cloud, to cart the remainder away as dusty ashes."

Of the desirability of replacing this dirty and inconvenient system by central stations and electrical transmission there can be no doubt, but how about the commercial economy? "Is it cheaper to burn the coal at the pit's mouth, and to convey the energy electrically to each of many machines situated within a radius of, say, ten miles from the electric generating center, or to load the coal on railway trucks, carry it in different directions to many factories, unload, stoke the furnaces at many places, and distribute the energy from the many steam engines by shafting, belting, rope-gearing, compressed air, or an electric current generated at the individual factory?"

The question of the cost of transmission depends mainly upon the limit of pressure permitted in the conductors, and while in America electrical pressures of 40,000 volts are allowed, the Board of Trade in Great Britain allows nothing higher than 11,000 volts, and the promoters of the four power bills above mentioned do not contemplate using more than 10,000 volts. With this pressure, however, the cost of underground cable was shown to be about £1,400 per mile, not a prohibitory figure. A second question affecting the selling price of energy is that of the relative constancy of the load factor. In the case of electric lighting the maximum demand exists during a small

fraction of the twenty-four hours of the day, and a far larger equipment is required at the station than if the demand was distributed more equably over the day. If the same plant is employed to supply light by night and energy by day the load factor is more nearly equalised, and it has been estimated that under such circumstances current could be sold to the consumer at $1\frac{1}{4}$ pence per Board of Trade unit at a fair profit, instead of the 4 pence or 6 pence now charged.

The conditions under which the new enterprises will probably be undertaken were fully set forth in these columns last month, and while there may be some delays and discussions as to what constitute reasonable prices and reasonable times, we may expect to see a beginning of electric power distribution in Great Britain on a large scale. In many cases the municipalities are already awake to the importance and value of their prerogatives, and in such places there is no need for additional service. The local authorities are now to be put on their mettle. "If you realise," says Sir James Kitson's committee, "what are your duties in providing all your people with an ample supply of electrical energy for all purposes, we will be no parties to any hindrance through competition being put in your way. But if your district be one in which Bumble-don reigns supreme, then our declaration is that no municipal barrier shall be left standing to oppose the free entrance of those who come with offers of cheap electric energy."

The Fouling of Ships.

WITH all the efforts which have been expended to attain speed and economy in the propulsion of ships there has been comparatively little progress made in the important matter of maintaining clean hulls. This bears such a close relation to speed, and hence to power, that it demands the attention of shipbuilders and ship-owners everywhere, and hence the paper of Mr. W. H. Atherton, recently presented before the North-East Coast Institution of Engineers and Shipbuilders upon the subject of the fouling of ships is of interest and value.

Mr. Atherton first examines the conditions under which fouling takes place; all being understood to occur in sea water.

The favourable conditions are as follows: Lying at anchor in shallow water; roughness of ship's bottom; high temperature, such as in tropical waters; local circumstances, certain ports appearing to be especially active with fouling germs. These are all circumstances which favour rapid fouling, but it goes on to a greater or less rapid extent in all salt water, and so is a matter of concern everywhere.

The principal effect of fouling of a ship is an enormous increase of the resistance experienced by the ship in its passage through the water; causing a loss of speed, and also in the case of a steamship, great waste of coal. By fouling, the coefficient of friction is quite commonly doubled; and ships occasionally become so foul that the skin friction mounts up to four times its value for a clean bottom.

The effect of fouling is very clearly shown by the comparative speed curves for the same ship with clean and with foul bottom. When it is understood that the power varies approximately as the cube of the speed, it will be seen what a waste is involved. Taking the case of a vessel capable of making 12 knots with 2,000 h. p., when clean, at 80 revolutions, she may be able to make only 9 knots when foul, this requiring about 1,500 h. p. Since the power required to drive the ship at 9 knots, when clean, will be only about 844 h. p., there is 44 per cent. wasted in overcoming the extra resistance.

The best remedy, and indeed the only real remedy, against fouling is copper sheathing. This was extensively used upon wooden ships before the advent of iron and steel construction, but in the latter case a new difficulty appears in the form of galvanic action between the copper and the iron, and consequent corrosion and destruction of the iron. The only manner in which this action can be prevented is to insulate the copper from the hull by an intermediate wood backing, this adding greatly to the expense. Attempts to electro-plate the copper directly upon the plates of the ship have been found objectionable because of this corrosion, and although it has been found entirely practicable to coat the hull with a continuous shell of copper, the excessive corrosion of the steel makes this method valueless.

When a copper sheathing is properly in-

insulated it certainly prevents, to a great extent, the fouling of a hull, but there are various theories as to the manner in which it acts. The most reasonable explanation lies in the fact that copper exfoliates, or oxidises in thin parallel layers, and these very thin layers are gradually shed off, and with them come the animal or vegetable substances which have attached themselves. The chemical, or dissolving theory, which is often confused with the preceding, assumes that there is a continuous formation of a soluble oxychloride of copper which washes off, carrying with it any fouling growths. Besides these there is the biological theory, which assumes that the formation of poisonous salts of copper kills the lower animal and vegetable growths, and prevents their adherence. No one of these theories has been positively demonstrated or disproved, and while the weight of opinion inclines toward the exfoliation theory, it is highly probable that all three actions take place in a greater or lesser degree at the same time.

Zinc has been suggested as an anti-fouling sheathing, and it possesses the great advantage of being electro-positive to iron, therefore protecting the latter from corrosion. The zinc, however, is very rapidly corroded itself, and becomes very rough, unless it is insulated from the iron, in which case it lasts much longer, but is proportionally less effective as an anti-fouler.

The high cost of copper sheathing has caused many attempts to be made to find a satisfactory substitute, and by far the greater number of vessels depend for protection upon some kind of anti-fouling paint or composition. Such compositions, while not as effective as copper, serve their purpose fairly well, the vessels being docked and repainted once or twice a year. From the composition of these coatings it appears that the poisoning theory is mainly held by their compounders, since the principal ingredients are a solution of gum, shellac, or resin in spirits of wine, naphtha, or other solvent, to which, in addition to a colouring pigment, there is added a salt of copper, zinc, arsenic, or mercury. The varnish or other medium is purposely made so as to be slowly soluble in sea water, allowing the action of the contained salts to progress gradually for about a year.

The value of such coatings depends largely upon the manner in which they are applied, and care should be taken to have the hull well cleaned and painted with a rust preventive. The anti-fouling composition should be applied in one coat and kept well mixed, to prevent the metallic salts from separating out, if the best results are to be secured.

The whole subject is one which would well repay a systematic and scientific investigation, and Mr. Atherton suggests that such a study should be made by a special commission, no one man being fully qualified for the task.

Boilers in the British Navy.

At last there is some possibility of definite information about the status of the water-tube boiler in the British Navy, and the many conflicting reports about the Belleville and other forms of steam generator should soon be superseded by definite data from which the engineer and even the layman may draw intelligible conclusions. This state of affairs is due to the fact that the whole matter has been referred to a special committee, with most comprehensive and liberal instructions as to the scope of the inquiry, and the result should be a most instructive and valuable report. From editorials in *Engineering* and *The Engineer* a general review of the composition and work of the committee is possible.

The selection of suitable men for the task was in itself a difficult matter, since nearly everyone possessed of the knowledge and experience is also apt to be interested in some of the types of boiler under discussion. Many prominent marine engineers have also expressed strong opinions upon questions at issue, and are to a certain extent committed to the support of those opinions, and for such reasons many men otherwise well adapted for the work have been considered unavailable. In spite of these difficulties a very strong and competent committee has been appointed. The chairman, Vice-Admiral Sir Compton Domville, has commanded fleets in which the ships have been equipped with cylindrical and with water-tube boilers. The remaining members of the committee are: Mr. List, the superintending engineer of the Castle Company; Mr. Bain, the superintending engineer of the

Cunard Line; Mr. Milton, chief engineer-surveyor of Lloyd's Registry of Shipping, who sat on the former Admiralty Committee on Boilers in 1892; Professor Kennedy; Mr. John Inglis, of the well-known Glasgow shipbuilding firm; and Mr. J. R. Smith, inspector of machinery.

The breadth of scope of the work of the committee is indicated in the instructions, which, while primarily stating is to be "to ascertain practically and experimentally the relative advantages and disadvantages of the Belleville boiler for naval purposes as compared with the cylindrical boiler," also to investigate the causes of the defects which have appeared in the Belleville boilers in the service, in order to find out to what extent they have been due to the system.

In addition to the comparison of the Belleville and the shell boilers, the committee is authorized to report on the advantages and disadvantages of the Babcock & Wilcox and the Niclausse boilers as compared with the Belleville, and also to report whether any other description of boiler is advisable for use in any of Her Majesty's ships. This important feature in the instructions permits the discussion of the suitability of the small-tube types which have come into such general use for torpedo boats and destroyers, but which have not yet been employed in any large cruisers and battleships.

A number of practical experiments will doubtless be made, since the Hyacinth, a cruiser with Belleville boilers, and a similar cruiser with cylindrical boilers, are to be placed at the disposal of the committee. All the reports which have been made upon the defects of machinery and boilers during the naval manœuvres will be at the service of the committee, and especial facilities given for making runs on ships in commission and examinations of boilers and machinery while in port. Any points thus brought out which may need further study will be supplemented by special experiments, and it certainly appears as if the desire to get at the real facts in an official manner is to be gratified.

Apart from the value of the work of this committee to the Admiralty, it should be most useful to steam engineers generally, since it must practically result in a complete treatise on marine-boiler construction. Pos-

sibly it may also be the cause of the evolution of some improved form of marine water-tube boiler better adapted for the service than any now in use; the results of experience certainly should offer opportunity to suggest numerous improvements.

It is to be hoped that the work of the committee will be pushed forward with all possible dispatch, not only for the welfare of the navy, but also because of the great general value of the information to the engineering profession everywhere.

American Coal in England.

THE much-talked possibility of American coal entering the English market, as a consequence of the rise in price, came to a concrete example by the arrival in London of a consignment of 3,700 tons from Philadelphia for the South Metropolitan Gas Company. The quantity itself is insignificant, but the fact is something for thoughtful examination.

A communication in the *Journal of Gas Lighting* discusses some points bearing upon the present situation which are interesting. The character of the coal was special, being the Westmoreland gas-coal, claimed to have a productive capacity 40 per cent. higher than ordinary English gas-making coal.

At the present time the cost of transport renders this American coal somewhat higher than English coal, but if experience supports the claim for the higher gas production it will be cheaper in the end, and the ostensible object of the importation is to ascertain the real quality of the coal. At the same time there is little doubt that the ultimate effect of the entrance of American coal into English markets will be to check the advance in prices by providing a competing supply whenever the limit is reached, and there is little doubt that this and other proposed importations are expected to be an object lesson to the British coal trade.

There can be no doubt whatever that the American coal operators are planning for a European market, and even if large direct shipments are not made to England, the export of coal from England to various parts of the continent may be checked by the entrance of the American product. Two main factors may be expected to influence the question. One is the question of transport, as it is in this that the controlling element

in price exists. Lines of colliers must be established, vessels chartered or built, and all the machinery for economical transport provided. This takes time, and money, and it is not to be expected that commercial enterprises of such magnitude will be undertaken without assurance that the advanced price of coal is to be maintained. The second factor is therefore the question of the stability of the market.

While the present prices are doubtless due to a combination of causes, and it is not to be expected that they will be uniformly maintained, yet it must not be forgotten that the demand is a constantly increasing one, and that almost daily new applications for power, demanding almost invariably more coal, are made. Higher speeds on railways and steamships add to the drain, while the demands for lighting and for electric traction are clear additions to the older manufacturing interests. In spite of fluctuations, therefore, the general tendency must continue upward unless foreign supplies act to check the pressure.

Several results may be expected to flow from the rise in coal, among them being an increased demand for fuel saving devices, or rather more attention paid to the arrangement and design of plant with a view to fuel economy. Many a steam engine is running to-day at a fuel cost on which a possible economy would offset the increased price of the coal, while the use of inferior fuels in gas producers for gas engine supply opens up a wide field for fuel economy. In similar line comes the utilisation of furnace gases, now wasted, but fully capable of being utilised for power to be distributed, not only throughout the works itself, but to outside subscribers. These and many other similar ideas will be developed just as soon as the pressure of increased coal prices shows them to be profitable, and thus there are other methods besides that of importing American coal.

The Reorganisation of Machine Works.

It is always easier to start right than it is to correct mistakes after they have taken root, and this is especially true in connection with industrial and manufacturing establishments. Just at the present time there is more or less agitation about the antiquated plant and methods of British ma-

chine shops, and while much of the talk is idle and unfounded, yet there is undoubtedly room for improvement in many instances.

The whole subject of the task of reorganisation is discussed in a recent editorial in *Engineering*, with so many remarks that are pertinent to the present situation that a review is most appropriate.

That reorganisation is in many cases imperative, if supremacy is to be retained, must be admitted. Change is continually going on without, and in spite of monopolies in patronage, ownership of patents, control of methods, etc., competition of improved methods in the hands of energetic rivals will not permit success to exist without progress. The competition which has existed in the past, and that of the immediate present, is only a foretaste of what may be expected, and there can be little reasonable doubt that the next generation will witness changes of which but few have yet any adequate conception. "It is not in one branch of engineering alone that these changes may be expected to take place, but in most, or in all. They will affect each section of manufacture vitally, and firms who cannot become adapted to change will fall out of the running."

Three main factors enter into the problem of reorganisation: design, methods, and men. These are considered in detail in the article to which reference has been made, but can only be glanced at here. In regard to new designs it is very possible to confound change with improvement, and while it is a mistaken conservatism which clings to old machines simply because they are tried old friends, it is a wise progress which anticipates improvement along the true lines of progress. The sage dictum of the old politician may well be remembered: "Find out which way the procession is going, and get in front."

The question of men is, and always will be, a difficult one. The training of the machinist is necessarily a narrow one, although much of this depends upon the man himself. New products, new methods necessarily involve the abandoning much that formerly constituted part of the trade, and when the workman sees what was a fundamental portion of his capital, his personal skill, becoming obsolete, he naturally feels that he should struggle to retain his

specialty. Here again the wise workman must follow the same lines as the wise employer, and endeavour to place himself in the forefront of the advancing procession, for he may be very sure he cannot permanently stay its progress, nor should he wish to if he could, since his own advancement is bound up with it.

But it is with the reorganisation of shop methods that the manufacturer is at present most directly concerned, and here, too, it is a mistake to undertake everything at one time.

"A firm may introduce new designs, have a tractable set of men, or have introduced much new blood, and yet it may fail in consequence of not possessing correct views relative to the best methods of carrying out its ideals. There may be the newest and best machinery without the knowledge of how best to take advantage of its capabilities; or machinery may be laid down suitable for the performance of one class of manufacture, but quite unfit for the work of the firm in question. Here, therefore, in reference to the methods of doing work, it is easy to err through ignorance, or want of clear-sightedness as to the conditions of manufacture. Bad work can be turned out on the best machines, slow work on the high-speeded machines; and operations may be done on machines for which they are not so well adapted as others. Money may be wasted on templates for which there is no need; and expensive plant may be laid down for doing a class of work that could be more economically done by other means. Some firms with plenty of money manage to go in the most uneconomical ways about their work, while others with little surplus capital or space, contrive to produce better results at comparatively slight expense. Many illustrations of these facts will occur to the mind, but it is sufficient to state them merely."

One of the first points where reforms may well be instituted is in the tool room, and very much more may be got out of old machines under a good system emanating from the tool room than some people would suppose. This portion of the works is especially adapted for instituting the reform of removing the care of tools from the hands of the workman and intrusting them to specialists, and paves the way for the

division of the workmen into skilled tool makers and comparatively unskilled machine tenders, an arrangement absolutely essential if full capacity is to be obtained from modern automatic tools.

As designs are modified repetitive processes may be introduced, and this naturally paves the way for piece-work prices and for a rigid store system based on a division of tasks. These may well be followed by the separation of the establishment into distinct departments, each having its systematic dealings with the others, and each held responsible for its own income and outgo. By following some such gradual and careful development success is much more likely to be attained than if a radical change be made all at once, and, although the whole scheme for reorganisation may be clearly formulated in the mind of the chief, it may well be installed gradually with much greater probability of success than if greater haste be attempted.

Gaseous Fuel.

THE advantages of gaseous over solid fuel have long been recognised, at least for a number of applications, and on the score of convenience, cleanliness, and wide adaptability no arguments are needed to enforce its claims. In the United States the numerous applications of natural gas are well known, and notwithstanding the somewhat diminished supply, still very extensive.

The applications of producer gas have been extensive in certain directions, and at the present time the use of blast furnace gases is not only a matter for discussion, but of realisation.

With the development of improvements in the production of water gas, wider applications of gaseous fuel must be expected, and in this connection the paper of Captain C. C. Longridge, in a recent issue of *The Engineer*, is most suggestive.

Water-gas, being practically all combustible, hydrogen and carbon monoxide, is eminently adapted for metallurgical operations, and has already found most successful applications in connection with reverberatory or open-hearth furnaces. Captain Longridge, however, suggests its use in place of solid fuel in blast furnaces, and makes out a very good case in its favour.

Although he advocates the use of water-

gas for iron furnaces, he discusses first the somewhat smaller problem of lead furnaces.

Commencing by an analysis of the reactions which occur in connection with solid fuel, Captain Longridge shows that the ordinary furnace must be so shaped and fired that carbon monoxide shall be formed at the proper point in order that the desired reducing effect may be produced. The action of such a furnace depends upon many factors, such as height of column of charge, shape of tuyere zone, area of tuyeres, volume and pressure of blast, and manner of charging the ore, these acting to regulate the manner of the formation of carbon monoxide. With the use of water-gas, however, the necessity for these regulating factors vanishes, because the carbon monoxide is produced outside of the furnace, and the whole problem is reduced to the regulation of the respective quantities of gas and air admitted.

"But water-gas has other advantages. One of these is the ease with which the fuel is burnt exactly where it is required, and the fusion zone is circumscribed within the desired limits. Where solid fuel is disseminated with the charge throughout the furnace, any irregularity of the blast, etc., may cause the combustion to creep upward, burning the fuel where it is not only useless, but absolutely prejudicial to the proper running of the furnace. With water-gas this is impossible, for the charge contains no fuel.

"A further advantage is the cleanness of the fuel. Water gas is not only easily purified from sulphur, which for iron and steel smelting, is of importance; but it is free from ash, which, for every kind of smelting, is an undoubted benefit."

While there are no absolute facts upon which the important question of economy can be determined, yet water gas made by a modern process, such as the Dellwik-Fleischer, should show a decided advantage over coke. The gas itself represents the possible utilisation of 80 per cent. of the calorific value of the fuel; it can be stored without deterioration; it can be applied without waste, and with almost theoretically perfect combustion; it involves no labour in charging; it admits of easy furnace regulation and safe running; and, owing to the absence of dust and ash, it

increases the output, and probably lessens the wear and tear of the furnace. Besides these notable differences, the water gas supplies, on an average, about 51 per cent. of hydrogen, which, acting as a reducing agent, should tend largely to augment the furnace capacity.

There are, undoubtedly, certain difficulties attending the use of gaseous fuel in high furnaces. One of the most important of these, affecting also the use of oil fuel and of charcoal, is the inability of such fuel to support a heavy ore burden. This difficulty is properly avoided by a different construction of furnace. Since the customary sequence of reactions is not required in using a fuel separately generated, a high ore column and heavy ore burden are not required. With fairly coarse ore, or with bricked fine ore, a furnace of modern height and width, and possibly a double or treble tier of gas inlets, no difficulty should be experienced.

Taking into account the experience which has been had with water-gas as a fuel for open-hearth furnaces, there seems to be every reason that, with the more economical methods of generating the gas, it may come to be an important factor, even in iron smelting; while for smaller furnaces for lead, antimony, etc., its success seems to be assured.

The Machinery of Fighting Ships.

IN commenting editorially upon a recent paper by Rear Admiral Melville, U. S. N., the *Engineer* discusses some of the characteristic requirements of the propelling machinery of warships as compared with vessels of the merchant marine, and brings out some useful points.

In an Atlantic liner, or any other high class merchant vessel, conditions are so nearly uniform that it is possible to accomplish the required result within a close degree of satisfaction. The engines are designed to work at the pressure which suits them best, quite irrespective of size, and they are always worked as far as possible at the same speed and pressure, that speed and pressure being the best possible.

In a warship, by far the greater part of the service rendered by the engines is to propel the ship at a cruising speed far below that which may be called for in time

of emergency. This means that with the usual construction the engines must be either far too large for their cruising capacity or much too small for economical performance at full speed. If an engine is underloaded the losses by cylinder condensation and internal friction are disproportionately great, while, if it is overloaded, the mean pressure becomes far too high for economical working.

"The best that can be done is to effect a compromise. The engines are designed to give the best results at some moderate cruising speed. For lower speeds they are too large; for higher speeds they are too small; and the further we depart from the best speed the worse are the results. For this reason it is most unfair to compare the performance of a fighting ship with that of an Atlantic liner. The fighting ship could only compete in economy with the liner if she was invariably run at one speed. In the case of the liner her most economical speed is also the fastest speed. If it is not, then her engines are too small. We may safely say that they are never too large. The engines of the warship do not work to the best advantage at full power."

The solution of the problem, according to Admiral Melville, is the use of triple screws, with three independent engines, and it is this treatment of the problem that the *Engineer* examines.

Those warships which have thus far been constructed with three propellers have had the power equally divided between them, but the present proposition is to make the wing engines of about half the power of the

centre engine, thus giving either a twin-screw combination or a single screw of equal power, or the full combination of double the power. Comparing the triple screws with twin-screw propulsion, it is safe to assume that with two ships of the same shape, displacement, and horse power, the economy at full power would be identical, while a part power for cruising the triple system permits the central engine to be thrown entirely out of service, while the wing engines may still be maintained at their economical power.

If this plan is not desired there are others which may be employed. Thus, with twin screws two sets of engines may be provided for each screw, the forward set being disconnected when cruising, but this plan showed its defects at Santiago, when some of the swiftest vessels in the United States fleet were unable to use full power in great emergency, owing to the time required for coupling up the disconnected engines. Another system is to provide for various combinations of the cylinders of each engine, so that the low-pressure cylinder of a triple-expansion engine may be shut off, the high and intermediate cylinders being worked compound for cruising. Up to the present time, however, the triple screw system appears to offer the greatest advantages. Apart from the possible subdivision of power, it permits repairs and adjustments to be made on the standing engines without interfering in any way with the operation of the others, and while a distinct economy in fuel has not yet been proven, it is equally true that no loss has been shown.



REVIEW OF THE CONTINENTAL PRESS

The Paris Metropolitan Railway.

WITH the starting of the first completed portion of the Paris underground electric railway attention has been called to the magnitude of the whole scheme proposed, and in a recent issue of *Le Génie Civil* the plans of the completed and projected portions are examined, with many illustrations of the work in progress.

The fraction of the underground railway at present completed and in operation extends clear across Paris from east to west, from the Porte de Vincennes to the Porte Dauphine, passing beneath the Bastille, Palais Royal, Champs Elysées, and Place de l'Etoile. This is known as Section A; the portions remaining to be built are as follows: Section B, a belt line, following the circuit of the old exterior boulevards; Section C, connecting the two previous portions on the north, from the Porte Maillot to Ménilmontant; Section D, the north and south transversal line, from the Porte de Clignancourt to the Porte d'Orleans; Section E, connecting the Boulevard de Strasbourg with the Austerlitz bridge; and Section F, connecting the Cour de Vincennes with the Place d'Italie. The extent of this work may be understood when it is stated that the portion already completed is only between one-fourth and one-fifth of the entire length, the whole amounting to about 40 miles. About 70 per cent. of this is entirely underground, while 16 per cent. is viaduct and 14 per cent. is cutting.

A general description of the work and the routes cannot give any adequate idea of the difficulties encountered, but it must be remembered that underground Paris is threaded with sewers, subways, and obstacles, and that in many instances an entire rearrangement of previous underground work was involved. In all cases the operating line is made double track, single tracks being used only where special connections have been provided between separate sections.

Without going into the details of the stations of the part now in use, some of the special points about them may be mentioned.

The terminal stations are of the loop, or racquet form, with the arriving and departing platforms on opposite sides, while the way stations are arranged with platforms on each side and a bridge or passerelle, to enable communication to be made across without crossing the tracks. At the Lyons Railway Station the Metropolitan is made with a so-called double station, this occupying a large space covered with a metallic platform, and being intended for use with a section of the belt line yet to be built, as well as for the present operative section. At the Place de l'Etoile, under the great triumphal arch, was some especially difficult work, since, besides approaching perilously close to the foundations of the great monument, the two sections of the road there cross, the one passing beneath the other.

The road is constructed with rails of the Vignoles section, of 52 kilogrammes per metre weight, the rails being 15 metres long, and carried on creosoted wooden cross-ties. The conductor-rails are carried by the side of the main lines upon insulators, and the return current passes through the track rails, which are effectively bonded together at the joints by four copper conductors.

The article referred to gives much interesting information about the construction of various sections of the work, which was divided up among a number of contracts. In some portions the tunnelling was accomplished by aid of the shield, in others the cutting was made open to the surface, and filled in after the arch or girder roof had been constructed.

Each train is composed of one motor car and two trailers, the motor car also containing places for passengers. The motors are of the Westinghouse type, there being

two of 100 h. p. each, on each motor car. These were constructed by the Société Industrielle d'Electricité at Havre. The motors are connected in series and for some seconds are capable of developing double their rated power. The authorized speed of trains is 36 kilometers per hour (about 22 miles) but the actual speed is 25 to 30 kilometers (15 to 18 miles) permitting the run from the Porte de Vincennes to the Porte Maillot to be made in half-an-hour, including stops.

Although the reports which have been made as to the actual working of the Metropolitan have not shown it to be rendering the relief to the congestion which was hoped, yet it is but natural that some time should be required for all to get in smooth working order. The fact that the present portion is but a fraction of the entire plan also renders it sufficiently incomplete to give it less efficiency than would otherwise be the case. At the same time it is to be welcomed, as is also the companion road in London, as the beginning of a transfer of the through traffic of great cities from the surface to underground ways, permitting growth without excessive congestion of streets and enabling time to be spent in useful and satisfactory occupation, instead of wasting it in a wild scramble to and from the scenes of activity.

Petroleum Fuel in Metallurgy.

THE disadvantages of solid fuel are now very generally recognized, and in another column we have discussed the desirability of using gaseous fuel for metallurgical operations. In many cases, however, it is desirable to use liquid fuel, without the intermediate stage of conversion into gas, and in this connection the paper of M. G. de Krivochapkin in a recent issue of *Le Génie Civil*, will be of interest.

In Russia, where petroleum is readily available as a fuel, there has naturally been attempted various methods of utilizing it to the best advantage, especially by the firm of Nobel Brothers, by whom the petroleum industry has been so extensively developed. As long ago as 1882 M. Nobel presented several communications to the Russian Imperial Technical Society at Moscow, and made the experimental demonstration of the fusion of a ton of cast

iron by the combustion of 66 kilogrammes of petroleum residue.

The principal innovation made by Nobel was the special form of grate upon which the petroleum residue was burned. This arrangement consists of a series of superposed troughs, placed at the entrance of the furnace, the liquid combustible being allowed to flow into them under the control of a device by which a constant level is maintained. A space is provided between each trough for the admission of air, and when the fuel is ignited the draft of air over the troughs maintains a complete combustion without requiring the use of steam jets or compressed air, thus giving a marked advantage over similar devices. The stream of burning gases from this device may be employed in a variety of ways. It may be directed over a series of crucibles for melting steel, in which case experiment has shown that 0.6 ton of petroleum residue has sufficed to melt a ton of steel, as compared with the combustion of 1.5 tons of coal.

For the evaporation of water it has been customary to use the steam atomizer, but with the Nobel system it has been shown that 14.35 litres of water have been evaporated per kilogramme of residue, as compared with 11.4 litres with the use of the atomizer. At St. Petersburg and in the Caucasus this arrangement has been used in connection with the reverberatory furnace for the fusion of copper in crucibles. The general arrangement does not differ greatly from the ordinary reverberatory furnace, the petroleum burners being placed in the position of the furnace door, and the grate being covered. The flame from the burning petroleum then streams over the bridge wall upon the hearth, and with the proper admixture of air, produces an intense heat. The use of petroleum residue is of especial importance in this connection in the Caucasus, in which wood and coal are almost entirely lacking, and numerous industries have grown up in the Baku region, depending upon petroleum residue as fuel.

Another application of petroleum as fuel is found in the so-called Quarnström furnace. This is a form of portable petroleum forge, especially adapted for heating rivets. In this furnace the troughs containing the

petroleum are placed at the bottom, with air spaces between, supplied by the natural draft. This furnace appears to work very well, but in order to avoid the production of too much soot it has been found best to employ the lighter hydrocarbons, instead of the petroleum residue.

An important application of the petroleum furnace has been in connection with glass works, in which the Kroupsky regenerator has been employed to advantage. In this case the furnace is provided with regenerators similar to the Siemens regenerative furnace for gaseous fuel, but instead of using the chambers of highly heated brick checker-work to heat the incoming air, they are employed to gasify the petroleum vapour, and thus render its combustion more complete and intense.

In connection with the manufacture of glass the Malichief furnace has also been employed, this more nearly resembling the ordinary Siemens regenerative furnace. Here the vapour of petroleum and the air both pass through the regenerative chambers, and are thus prepared for most complete combustion. It is asserted that in these furnaces 1.3 tons of petroleum residue will melt 4 tons of glass.

These illustrations show that Russia is making active progress in the utilisation of petroleum as fuel, and that possibly other parts of the world may have some lessons to learn from her.

The Port of Bilbao.

IN view of the present interest experienced in the development and export of Spanish iron ores to England and other parts of the world, the paper of M. L. Coisseau, recently presented before the Société des Ingénieurs Civils de France, and published in the *Memoirs et Comptes Rendus* of that society, demands notice and review.

Bilbao is one of the most important mineral centres of Spain, the excavation of iron ore amounting to nearly 6,000,000 metric tons per year. As a natural consequence there are also numerous other industries, including blast furnaces, steel and iron works, rolling mills, tube mills, and other manufacturing establishments extending along the banks of the Nervion. As the iron mines are open workings there are no especial methods demanding attention.

Transportation devices of all sorts, from the mediæval ox-cart to the modern aerial cableway are in use, as well as railways, inclined planes, and cable traction.

The Port of Bilbao, at the mouth of the river, through which practically all this traffic must pass, has long been the object of attention. Since 1878 the tonnage of the port has risen from 1,340,000 to more than 5,000,000 tons, of which 4,800,000 tons consist of iron ore, thus rendering the port not only the most important of the Spanish Peninsula, but also one of the most important of the continent of Europe. Under these circumstances it is not surprising that every effort has been made to create and maintain a satisfactory waterway in the river, as well as suitable harbor improvements at the port.

The first portion of the work was that of the improvement of the river. Down to 1878 the stream flowed over an irregular bed, with sharp bends and numerous shoals, rendering navigation impossible for boats drawing more than 10 to 12 feet of water. The mouth was obstructed by a bar, and the tide varied from 15 feet in the equinoctial season to a minimum of 4 feet, the yearly mean tide being 11.8 feet.

The work was commenced by the regulation of the channel in the river. The sharp bends were replaced by curves of longer radius, dikes were built to contract the channel at the excessively wide portions, and dredging was resorted to to remove the shoals. At the present time there is a depth of 13 feet from the mouth of the river up to the city of Bilbao at low tide.

A study of the bar at the mouth of the river showed a tendency of the currents to transport sand from the east to the west side of the entrance, while the action of the north-east gales reversed this effect. The engineer, M. de Churrua, came to the conclusion that the deposit could be prevented by a proper breakwater construction, and that under such circumstances a channel produced by dredging could be maintained.

The works included the construction of a mole or jetty carrying the left bank of the river, by the town of Portugalete, out into the bay, thus conserving the force of the current beyond the point when the sand might deposit; a slight curve directing the flow against the opposing outer current.

Beyond this jetty two breakwaters had already been constructed, enclosing the inner harbor, acting to break the force of the waves in rough weather, and provide a safe place for vessels entering the harbor and awaiting entrance to the river.

A large portion of the paper of M. Coisseau is devoted to the construction of the jetty at the mouth of the river, this important piece of work being 2,600 feet in length, extending beyond the extremity of the bar into a depth of 23 feet of water. The foundation of this jetty, from the bottom up to low water, is composed of loose rock, no piece being less than one ton in weight. The first 1,800 feet of the jetty is composed of screw piles carrying a framed truss work of which the top is 25 feet above low water. Between the piles, and resting upon the rockwork below, is a solid concrete filling, to guide the currents produced by the tides, and thus aid in scouring out the channel. The action of the waves was too strong to permit this construction to be used for the outer portion of the jetty, and hence a filling of concrete was worked into the rock foundation and upon this was erected a solid superstructure of large blocks of artificial stone. At the outer extremity the jetty is 13 feet thick, and the foundation is also much enlarged, in order the better to resist the powerful action of the waves.

These works were finished in 1890, and since that time the channel has steadily deepened, so that there is now a channel of $6\frac{1}{2}$ feet deep for a width of 250 feet, while along the line of the jetty there is a depth of $16\frac{1}{2}$ feet, decidedly more than had been hoped for.

As a result of this success, vessels of 20 to 22 feet draught can now enter at high tide, where formerly boats of 12 to 13 feet draught hardly dared venture, and the tonnage of the port, as already stated, has risen from 1,340,000 in 1878 to 5,800,000 in 1896.

The especial importance of this improvement at the present time lies in the dependence of England upon Spain for much of her iron ore, and indeed it is to the rich beds of the Spanish Peninsula that England looks to enable her to compete with the Minnesota supplies which have done so much to develop American iron production. With iron, as with coal, the question of transport may yet become the controlling

one, and intimately connected with this is that of harbor and terminal improvement, of which this example of Bilbao is such a striking instance.

The Baltic-Caspian Canal.

ALTHOUGH it is generally understood that the internal waterways of Russia are of great extent and importance, yet from an engineering standpoint they have not been examined as their importance demands, and hence the report of MM. Suquet and Fontaine, published in a recent issue of the *Annales des Ponts et Chaussées*, is of especial interest. These two engineers, having been commissioned by the French Department of Public Works, and aided by the cordial co-operation of General Petroff, of the Russian Ministry of Ways and Communication, have made a thorough examination of the waterway from St. Petersburg to the mouth of the Volga, a distance of more than 2,500 miles.

Although we have referred above to the system as a canal, it is really composed of rivers, partly canalised, and of short portions of canals, forming a mixed system of waterways, of which the greater portion consists of the river Volga. This great river, which has its rise in the Valdai plateau, only about 125 miles from St. Petersburg, after being fed by a number of important affluents, empties into the Caspian Sea, after a course of 2,200 miles. With the rivers and canals which connect it with St. Petersburg, it forms the longest navigable waterway in Europe, and during the seven months in which it remains free from ice the traffic attains 5,000,000 tons.

In describing this important waterway it may be divided into two sections; the first, called the "Système Marie," about 700 miles long, including the canals and canalised rivers between St. Petersburg and the Volga, and the second, the Volga itself.

From St. Petersburg to the Volga the waterway traverses the Neva, the lakes Ladoga and Onega, the river Vytegra and Kovja, lake Bielo, and the river Cheksa. Of these the Neva is well-known, extending as it does from the Gulf of Finland to St. Petersburg, and improved by the Neva canal from Kronstadt to the capital. Passing on to lake Ladoga and the river Svir to lake Onega, the river Vytegra is reached,

and after ascending the rapids, the canal connecting with lake Bielo and the river Cheksna carries the navigation over the divide, into the upper waters of the Volga.

In all this portion of the navigation artificial improvements have been made, extending from the canal of Peter the Great, from the Neva to Volkhof; of Catherine II., from Volkhof to Sias; and the canal of Alexander I. from Sias to Svir, of the earlier improvements, down to the modern works constructed during the reigns of Paul, Alexander II., and Alexander III. Owing to the rough weather on the lakes it has been found necessary to construct canalised ways skirting the banks, and in the preservation of the embankments of these canals is found one of the important problems connected with the maintenance of the communication system.

Another feature of importance is the construction of channels in the rapid currents of the Svir and the Vytegra, as it is in these streams that the ascent is mainly made over the elevation beyond which the head waters of the Volga begin. Here a number of locks are required, and mechanical haulage has also to be used to overcome the current. It is impossible to go into the details of the improvements as they are described in the report, but while some of the works appear more or less primitive, it will be found that they are the result of long experience in the difficult conditions which have to be met, especially in the face of distance from supplies or headquarters.

The boats used upon the waterway are peculiar, and vary according to the character of the burden and the locality from which they come. In many instances they are intended for but a single journey, being taken to pieces and sold for the timber. This is especially the case with the boats going from the timber-working country of the Cheksna and Kovja to St. Petersburg. A special form of boat is used to transport petroleum from the Caspian to St. Petersburg, and as these are 250 to 325 feet long, they are arranged to be divided into two parts in order to permit them to pass through the locks.

When the Volga is reached the navigation becomes more that of a commercial river and less of a canal, although there are numerous artificial improvements and ca-

nalizations. Many of the cities have important wharfage facilities, as at Rybinsk, Nijni-Novgorod, Kazan, Tsaritzin, and other points are important commercial centres.

At the delta of the river, where it discharges into the Caspian, the two towns of Petropaulsk and Astrakhan form important trade centres, and since 1845 important improvement works have been conducted.

Lack of space prevents any discussion of the details of the engineering works upon this immense waterway, but the memoir of MM. Suquet and Fontaine gives a scientific account of what has been done and what may be done in the future, and when the dependence of such enormous areas upon engineering works is fully understood it will be seen what the effect will be when such projected works as the canals uniting the Don to the Black sea, and the Siberian waterways are completed.

Wind Pressure.

SOME time ago attention was called in these columns to the address of Sir John Wolfe Barry before the British Association, in which he maintained that the usual allowance for wind pressure upon bridges, buildings, and framed structures generally was excessive, and required unnecessarily heavy dimensions. It was then also pointed out that the experience of the hurricane at St. Louis, U. S. A., had demonstrated by the computations of Mr. Julius Baier upon structures overthrown, that the customary allowances were none too great.

We now have an elaborate discussion of the whole subject of wind pressure in a paper by Herr R. Kohfall in the *Zeitschrift des Vereines deutscher Ingenieure*, which examines critically, not only the absolute pressure of the air, but also the manner in which we may reasonably suppose it to act.

For the actual magnitude of the wind pressures, the experiments of Zeppelin are taken, and compared with those of Sir Benjamin Baker upon the Forth Bridge Works. These are also compared with the results obtained by long observations at the Hamburg Seewarte, the official weather observatory of Germany, and the deductions are discussed in a very complete and scientific manner.

In general it is shown that experiments

made upon wind gauges of small area give results which are too high, and that more reliable data are obtained by using surfaces of greater area, this agreeing to a certain extent with the position of Sir John Wolfe Barry.

The measurements, as compared by Herr Kohfall, show that the observed wind pressures, when acting normally to the exposed surfaces, range from 100 to 220 kilograms per square metre, or about 10 to 20 pounds per square foot. This rather agrees with the statement of Sir John Wolfe Barry, in which he maintains that the customary allowance of 56 pounds per square foot is about 60 per cent. too high, and may lead to a modification in engineering practice in this respect. At the same time it must not be forgotten that it is the extreme maximum pressure which must be provided for in the case of all framed structures, and the fact that the pressure increases with the square of the velocity renders caution most necessary. The case of the St. Louis hurricane has already been cited, and the terrible disaster at Galveston has again shown how the fury of the wind can sweep aside whole cities, and it well behooves the engineer to go very cautiously in modifying or reducing his constants of wind pressure. It is most desirable that all possible data should be accumulated on a subject which in many instances is of controlling importance, and the action of wind forces should be discussed as Herr Kohfall has discussed them, for every practicable application and action, but any attempt to reduce their assumed maximum effect should be based, not upon theoretical conclusions, but upon the actual results which have been experienced in various parts of the world. There are numerous instances of well determined structures having been damaged or even overthrown by the action of the wind. The stability of these can be computed within reasonable limits of accuracy, and from these we may determine what the wind really has done in the past, and deduce what it may do in the future.

River Regulation.

THE control of currents, the protection of banks, and the production of satisfactory channels have long formed a branch of civil

engineering of importance, but notwithstanding the study which has been given to the subject it is still more or less empirical in actual practice. For this reason the paper of Herr Ignaz Pollak, in a recent issue of the *Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines*, is of value, since it gives a brief review of past practice, and endeavours to gather experience into some kind of system.

The action of flowing water is not that of direct progress, but is composed of swirling eddies and direct and reverse curves, all of which go to make up the general movement. These movements produce centrifugal and centripetal forces which act upon the banks and bottom of the channel, and are in great degree responsible for the changes which occur.

Herr Pollak refers to the theory of Professor James Thomson, showing the formation of river channels in alluvial soil, and discusses the laboratory experiments conducted by Professor Engels at Dresden, in which the influence of currents upon sand of various sizes were made, in order, if possible, to reproduce the conditions which actually occur. These are compared with the theory of Girardon, which, according to Professor Pollak, comes the nearest to the actual behaviour in observed streams.

Instead of endeavouring to compel the stream to follow a determined channel, it should be regulated or guided so that the channel may be created and maintained by the forces within the flowing water. This natural channel is the one which is followed by the stream at low water, and the curves traced out under this condition may guide in indicating the nature of the regulating works to maintain the course of the stream during high water and in time of flood to control it.

An example of the adoption of this principle in practice is seen in the improvement of the Weser above Bremen, conducted under the direction of Franzius. Here, for a stretch of 900 metres in length, two reverse curves were to be controlled, and by observing the natural action of the water in forming its channel at low water the improvements were designed. Another application of the same principle is found in the work upon the Rhine between Basel and Dettenheim, conducted by Faber.

Herr Pollak brings up the question whether, for commercial purposes, especially internal navigation, it is better to attempt to improve and regulate natural waterways, or to construct entirely new canals. In many instances regulation can be readily effected at a moderate cost, and new waterways would be out of the question, but in others the difficulty of maintaining the natural channel in navigable condition renders it advisable to parallel the stream with a canal and use the river merely as a feeder.

Herr Pollak goes into the whole subject from a broad, general standpoint, and while he admits that each case must be largely decided on its peculiar conditions, yet he shows the great desirability of following the natural laws indicated by the behaviour of the stream itself, rather than any attempt to confine it within a channel, which however convenient it may be, is distinctly opposed to that which it naturally inclines to follow.

The Banki Motor.

AN interesting feature of modern mechanical development is the marked attention which is being given to heat motors other than the steam engine, and the remarkable development of various forms of the internal-combustion motors is most interesting. Among the more recent inventions in this line of work we have already noticed the motor designed by Professor Donát Bánki, of Budapest, and now we have very full accounts of its latest performances in recent issues of the *Zeitschrift des Vereines deutscher Ingenieure* and in the *Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines*, from which we make some abstracts.

It is now generally realized that in order to obtain high economy in an internal combustion motor a high compression must be employed. In the ordinary gas or petroleum motor the limit to the compression is attained when the temperature of compression reaches the ignition temperature of the mixture of gas or vapor and air. If this ignition temperature is reached before the end of the compression stroke there will be a premature explosion, the motion will be reversed and the motor will fail to operate satisfactorily.

In the case of the Diesel motor this diffi-

culty is avoided by compressing the air alone, and only injecting the liquid fuel at the moment when the combustion is desired, and this method also utilises the heat of compression as an igniting device.

Professor Bánki adopts another method. The charge of mixed air and hydrocarbon vapour is drawn into the cylinder as usual, but with it is also mingled a fine spray of water. When the high compression is given to this mixture the water absorbs a portion of the heat of compression and thus the temperature may be kept below the ignition point. When the combustion does take place the conversion of the water into steam adds to the expansive power of the charge and thus aids in the power stroke, and at the same time the absorption of heat in the generation of this steam aids in keeping the cylinder from becoming overheated.

In the paper of Professor Meyer, above referred to as appearing in the *Zeitschrift des Vereines deutscher Ingenieure*, the construction of the motor is clearly shown by drawings and sections, and in general it differs but little from an ordinary vertical gas or petroleum motor. The principal addition lies in the device attached to the inlet passage to provide for the admixture of the water spray.

With this arrangement of parts it has been found possible to work with as high a compression as 16.4 kilogrammes per square centimetre (233 pounds per square inch), without causing pre-ignition of the mixed charge, while the pressure of explosion attained is 39 kilogrammes (540 pounds).

In the tests made by Professor Meyer and others, the fuel used was benzine, this being found most satisfactory, and very full data and results are given for a series of trials upon a motor of 20 horse power. The motor was operated at powers ranging from 26 down to 8 brake horse power, and showed a thermal efficiency, on the brake, of 28 per cent. when operating at full load.

When it is understood that this includes the internal resistance of the motor, and that trials showed the mechanical efficiency of the machine to be only 74 per cent., it will be seen that this is an excellent performance, decidedly higher than would have been possible under ordinary conditions. The action of the injected water is

well seen in the diminished proportion of heat rejected in the cooling water of the cylinder jacket. Instead of 40 per cent. of the heat being carried off in the cooling water, as is the case with gas engines of the ordinary construction, the loss in this way ranged from 21 to 27 per cent., thus showing that a large proportion of the heat usually rejected in the jacket was taken up by the water into the cylinder, where it was converted into work.

The idea of injecting water into the cylinder of an internal combustion motor is not entirely new, and Professor Meyer points out the fact that in the early gas engine of Hugon, water injection was used to cool the cylinder. In such an engine, however, there was little or no compression, and the injected water did not act to improve the efficiency of the machine, while in the Bánki motor the action has been combined with the use of high compression in such a manner as to constitute a material improvement.

It remains to be seen to what extent this form of motor can be satisfactorily used with petroleum and the heavier hydrocarbons, since it is possible that the cooling effect of the water spray may limit the machine to the use of benzine and similar fuels.

In any case it is an interesting example of the ingenuity which is being applied to the development of the internal combustion motor, which will doubtless ultimately aid in establishing its superiority as the heat motor of the immediate future.

Corliss Engines at the Exposition.

At the Philadelphia Centennial Exhibition the motive power was entirely furnished by the great Corliss engine which stood in the center of the machinery hall, while at Paris in 1878 Mr. Corliss received an award, although he made no individual

exhibit, this distinction being given to him because of the extent to which his system of valve gear was shown by other builders. At the Paris exposition this year there might well be a similar recognition of the impress which Corliss has made upon steam engine design, for practically all the engines, with but few exceptions, show evidence of one or more of the points included in his system.

A large majority of the engines shown have the Corliss cylindrical valve, and where the movement is not given by the well-known wrist-plate action, some modification of it is employed. Even where, as in the well-known Sulzer and Culmann valve-gears, the poppet valve is employed, the Corliss principle of regulating the speed by varying the point of cut-off under control of the governor is retained, so that the action of the steam is practically that which he advocated.

The main advance which has been made over the practice which Mr. Corliss introduced is seen in the very general use of compounding, and this is mainly due to the fact that improved boiler practice enables pressures to be used sufficiently high to make compounding of advantage.

With the exception of minor details steam engine design at Paris showed adherence to a few fundamental points, and these may be enumerated as follows: The use of four valves to each cylinder; independent connections for each valve; a quick and wide opening of admission ports, with detached, quick closing movement, aided and controlled by the use of the dash-pot; the time of closing determined by the governor, regulating the speed by the point of cut-off; and the general use of compounding.

All these points, except the last, are due to Mr. Corliss, and it is not too much to say that the motive power section at Paris is a monument to the work of the American engineer.



The Height of Buildings.

AMONG the valuable papers presented before the recent convention of the American Society of Civil Engineers we may note an interesting discussion between Messrs. C. T. Purdy and Reginald P. Bolton, upon questions relating to the modern tall building. The subjects as proposed were: "What considerations should limit the height of buildings?" and "Do recent developments in construction, sanitation, intercommunication, and economy of administration, warrant the removal of all restrictions?"

The modern tall building is the outgrowth of demand for more room on a given site, and the hard conditions of competition, more than anything else, are responsible for its development. Under such circumstances any attempt to limit the height to which buildings may be erected must prove most difficult, since it cannot fail to discriminate between places and persons in a manner certain to arouse opposition.

Mr. Purdy, after a brief description of some details of tall building construction in New York and elsewhere, proceeds to enumerate some of the more important points to be considered in fixing or removing legal restrictions to the height of buildings.

Without going into these as fully as is done in his communication, the general points made are that tall buildings are objectionable because of the disturbing effect on land values, the exclusion of sunlight from the streets, the congestion of traffic, the difficulty of fire protection, and the excessive demands upon water supply and drainage facilities, to which may be added the æsthetic considerations, which should surely receive consideration.

In Mr. Purdy's view these objections are of minor importance for buildings not higher than fourteen or fifteen stories, but he is of opinion that the height of buildings

should have a reasonable limitation. The newer buildings are undoubtedly superior to the earlier ones, both because of improvements in materials and methods, and because of the experience which has been gained in construction during recent years.

Mr. Bolton, who has had much experience in the equipment of tall buildings in New York, believes that the limitation of the height of buildings should be left to practical and economic action, and thinks that legislation or municipal interference cannot produce desirable results.

So far as some of the objections advanced by Mr. Purdy are concerned, they may be construed into positive advantages. The construction of a tall building on a neighboring lot, while temporarily interfering with the immediate supply of light, and, possibly to some extent, of air, enhances the value of the neighboring properties, since, on its success, they become equally capable of improvement. Very often the deep underground excavation and sub-soil drainage involved in tall building construction materially improves the sanitation of the surrounding district, both by revealing buried defects, and providing means of removal of leakage.

"The relative increase in the value of a piece of land, by reason of the construction of a lofty neighbor, may be gathered from what has proved to be the case in New York City.

"Land, which with four-story buildings has barely paid expenses and taxation, has, with a lofty building, been able to earn all expenses; pay interest at the rate of 4 per cent. upon mortgages, the extent of which greatly exceeds the value of the original buildings; also pay a largely increased taxation, sometimes as much as five times the old rating; and, finally, leave a substantial profit on the net capital invested."

There are certain natural restrictions which act to prevent excessive height unless accompanied by proportionate areas.

When a very tall building is erected upon a limited area the question of elevator service affects the desirability of the upper floors.

Again, the cost of maintenance of the upper floors in extremely high buildings is often disproportionate to their returns. In winter they demand an excessive amount of heat for warming, and the cost of water supply is at all times greater than for the lower floors.

Upper floors are generally considered more desirable by tenants, because of the removal from street noises and dust, and elevation above heated streets in summer. With imperfect elevator service, however, such as is sometimes unavoidably the case, the upper floors are practically removed by a distance of possibly 200 feet from the main street, with as much delay as if on the surface.

An important feature, noted by Mr. Bolton, is that in many large buildings the mechanical equipment reaches the proportions of a small central station, and can produce power in several forms under the most economical conditions. The fact that all the waste steam can be utilized for the necessary heating of the building in winter and for other useful purposes, such as heating water and cooking in summer, places these equipments in a position superior to the central station of public supplies.

It is capable of proof that supplies of power in several forms can be sold by such large buildings to neighbors at figures very much less than the present cost of public supplies. Such advantages may thereby be presented to a contiguous property as will of themselves overcome the objection to interference with light or air, and there is apparently no reason why a tall building should not, by such arrangements, be a source of improvement to its older neighbors, and thus directly, as well as indirectly, add to their value.

The Corrosion of Boiler Tubes.

ONE of the special difficulties now being encountered in the generation of steam on vessels, both of the American and British navies, is that of the pitting and corrosion of the boiler tubes, and this feature will doubtless form the subject of a portion of the report of the British Parliamentary com-

mission, referred to elsewhere in this issue. At the same time the excellent paper of Lieutenant Commander Walter F. Worthington, U. S. N., published in the *Journal of the American Society of Naval Engineers*, is worthy of examination, as showing the experience which has been obtained in the United States Navy.

Mr. Worthington calls attention to the difficulty of drawing conclusions of any value from the ordinary records of various ships. The extent to which the various boilers are actually used is an important factor, also the service in which a ship is employed and the part of the world in which she has cruised. Some commanding officers and chief engineers are desirous of maintaining their boilers in a high state of efficiency, while others are anxious to keep down the cost of maintenance. When salt water has been permitted to enter the boiler the scale, although reducing the capacity of the boiler, and being dangerous to the combustion-chamber sheets and furnace crowns, has the effect of diminishing corrosion. Different kinds of fresh water also have different degrees of corrosive effect, and the conditions are so different in different cases, as to render it almost impossible to obtain comparable results.

For the above reasons it is undoubtedly advisable to look elsewhere than to naval records if we wish to learn anything about the corrosion of boiler tubes. Instead, Mr. Worthington examines the various causes to which corrosion may be due, and takes them up seriatim, in connection with such reliable experiments as may be available.

The usual reasons given for the corrosion of boiler tubes are as follows:

1. Fatty acids from decomposition of animal or vegetable oils.
2. Hydrochloric acid, due to the decomposition of the $Mg\ Cl$ in sea water at a high temperature.
3. Galvanic action.
4. Use of salt water.
5. Presence of carbonic acid in water.
6. Presence of air in water.

Since only mineral oils are used in vessels of the United States Navy, it may be safely assumed that the first cause is absent. Experiments in connection with the liberation of hydrochloric acid by the decomposition of magnesium chloride, have

shown that while this is possible, the acid is always immediately appropriated by some base other than the boiler metal. If the corrosion in any case were due to hydrochloric acid, chloride of iron would be found in the boiler water, and this has not been done.

Galvanic action may be due to the different position on the electrical scale of clean iron or steel and mill-scale, since experiments have shown that when plates, which have not been freed from mill-scale are connected galvanically with plates free from mill-scale, an electric current, capable of being measured with a galvanometer, is set up. Corrosion from this source can only be prevented by removing the mill-scale from the water side of the tubes, or by using only seamless tubes, which are thoroughly pickled during the process of manufacture, and have no scale left on when completed, and by substituting galvanized steel or iron for brass internal feed pipes.

Sea water is known to be a better solvent of steel and iron than fresh water, and is also objectionable on account of the formation of scale. Fresh water should always be used, unless, in cases of great emergency, and if it was used exclusively galvanic action would be out of the question. All fresh water is not desirable, however, since the presence of organic matter is apt to cause the production of carbonic acid, enumerated under the fifth head above as a corrosive agent. Carbonic acid has been demonstrated to be an important factor in corrosion, not only because of its own direct action, but because it acts as a carrier for oxygen, and a very small quantity is sufficient, since it brings the oxygen into combination with the iron, itself not being used up in the operation. It is impossible to detect by litmus the presence of the small proportion of carbonic acid sufficient to cause this effect, and the only thing to be done is to test the water for organic matter, observing whether or no it is darkened by the addition of hydrosulphuric acid. As it is often impossible to choose the water which may be offered, the proper remedy is to provide sufficient evaporator capacity to render the vessel independent of outside sources of supply.

Air in water can only be removed by prolonged boiling, but in Mr. Worthing-

ton's opinion the presence of zinc has a considerable effect in neutralizing the oxygen.

"The tubes of our boilers may be made to last longer in the future than they have done in the past if engineers will be governed by the following rules, which have heretofore been more honored in the breach than in the observance: Allow no tube or plate to enter the construction of the boiler with mill scale on the side in contact with the water. Use galvanized iron or steel instead of brass for internal feed pipes. These may rust out, and should be made easily renewable. Provide evaporator power enough to insure a sufficient supply of fresh water, so that it will never be necessary to use either sea water or fresh water of doubtful quality from shore. Provide fresh water reserve tanks, so that the boilers will never have to be used as storage tanks. Keep all boilers closed, the water at a constant level and above the tubes, and, by use of caustic soda or caustic potash, at all times sufficiently alkaline to turn red litmus paper blue. Use zinc plates of the standard size, 12 inches by 6 inches by 1 inch, distributed beneath the surface of the water. Finally, keep the temperature of the feed tank up to nearly boiling at all times.

"After all this has been done by the engineer there still remains the problem for the tube manufacturer to furnish tubes of some material less corrodible than iron or steel, and above all, to produce tubes more uniformly corrodible. At present a lot of tubes are put into a boiler, side by side, under identical conditions in every respect. One of them will corrode through in six months and another in six years.

The American Society of Municipal Improvements.

THE recent convention of the American Society of Municipal Improvements, while not without value in itself, calls attention to what must be considered the present tendency to the multiplication of societies and similar bodies to an unnecessary and possibly injurious extent.

The present practice of engineering is actually tending more and more to unification in methods and products, the specialization being rather that of individuals than of working bodies, and it really seems as if the four great national societies, the Civil,

Mechanical, Mining, and Electrical engineers, should cover the ground far better than any number of smaller specialized bodies. Municipal engineering is mainly included in civil engineering, with the possible exception of some branches of water-works practice, which fall under mechanical engineering, and it really seems as if membership in some one of the various grades of the national society would do more to further the work than any auxiliary organization.

The same is true of the society of heating and ventilating engineers, which is certainly entirely within the field of the mechanical engineers, and similar examples might be cited in connection with electrical engineering.

In regard to municipal engineering it may be maintained that much of its work relates to matters of administration, largely political in nature, and not such as would come before a society devoted solely to engineering. It is not to be expected that any technical society can exert an appreciable influence upon the domain of what has aptly been termed "practical politics," but there is no good reason why a society of civil engineers should not discuss details of management in municipal engineering. Some of the most valuable papers and discussions before the American Society of Mechanical Engineers have related to the economics of engineering, including works management, cost-keeping, and commercial work, and the trained engineer of to-day must possess some degree of familiarity with the business details of his profession if it is to be successful.

Municipal life, and indeed life in all parts of the country, is coming more and more under the rule of the engineer, and it is not too much to say that the time must come when the engineering side of government will dominate, just as the engineering side of warfare has already assumed control.

For such reasons it appears extremely unfortunate that there should be such division of effort and undoubted duplication of good work, as must necessarily follow when various branches of engineering are divided up among a number of minor societies, instead of being concentrated in the hands of some one of the great bodies containing members from all branches of the

profession, and eminently capable of providing expert members for committees upon each department of engineering work. Instead of endeavoring to provide a society which should include politicians and local reformers, the engineering problems of municipalities should be freely and fearlessly discussed by engineers in their own existing organizations with such energy and publicity as to make the actions of interested political leaders too conspicuously defective as to permit them to continue.

The metropolis of the United States had, for too short a period, an able engineer at the head of one of the great municipal departments, with the result that that department became the admiration and imitation of the rest of the country. It required no municipal society to accomplish such a result, simply the placing of power in the hands of a competent engineer.

Some day, when engineering problems become even more the ruling questions of a city than now, the engineer will be the chief officer, and duties now attached to the ruling offices will be performed by minor clerks, but it is too much to expect such a desirable result to emanate from a host of minor associations.

American Engines in England.

In discussing some interesting phases of international trade in a recent issue of the *American Machinist*, Mr. W. H. Booth makes some comments well worthy the attention of American manufacturers.

No matter how well built or generally satisfactory a machine may be, if there are petty annoyances about it, due to neglect of minor details, dissatisfaction is certain to result. As an example Mr. Booth notes the unsatisfactory indicator gear attached to many steam engines sent to England from America.

"Nothing could be worse. There is a pillar carried off a slide-bar bolt. A lever swings from a loose and badly fitted pin in the pillar head, and there is a quadrant on the lever that does not provide a pull short enough for any high-speed engine indicator, so that it is useless. Beyond this, on the back stroke the swinging lever is drawn back hard against the hood, and has to be cut out to clear this. Such is the gear supplied, not of a single maker

only, thus proving that the gear had not been even put together, either in fact or on the drawing board."

Then there is the mistake of providing unfamiliar screw threads. In England the Whitworth thread is used exclusively, and while it may not be necessary to use Whitworth threads for bolts and permanent portions of the machine, yet for such purposes as indicator connections the standard three-quarter Whitworth inside thread should certainly be provided.

"As made, engines come over with all sorts of threads, and reducing nipples have to be made, and as the threads are not standard, they have to be cut on a lathe instead of being more easily and quickly screwed by taps or dies. A great defect noticed is the want of uniformity in small details. For example, two set-screws for securing similar cotters at the two ends of a valve-rod were not even alike in their heads. A separate spanner was required for each, and there was no reason of safety, or any other reason, why they should not be identical. The same remark applies to various nuts about this same engine. This is not an exceptional case, nor is it drawn from any engine made by an unknown firm or firms. I do not say that similar faults are not to be found here on English-made engines, but I name them because it is claimed that all American machinery is made interchangeable, and yet in scores of ways this is not the case with the productions of firms that stand high in their special lines. The system of interchangeable manufacture is one that should prevail, but it is an exceedingly bad system when only imperfectly carried out, and I know by experience that it often is very imperfectly carried out, even to the neglect of leading dimensions."

Mr. Booth has also some timely words about the commercial side of the machine trade in England. He affirms that no good and continuous business will be founded by any firms who are not prepared to grant exclusive agencies, and to act honorably by their agents. Agents of standing will not undertake business unless assured of permanency, because of the large initial expenses in building up a trade, and unless they have an exclusive right to a certain territory they may do a lot of work only

to have the work taken out of their hands by some other agent, who has simply come in at the last minute. Principals often will not recognize the years of preliminary hard work by the agent, but grudge him anything more than a bare living when he begins to reap the reward of his accumulated labor.

"In other words, machine-tools, engines, and other vehicles, are not sold in Europe by placing samples in a storeroom and expecting customers to come and buy, but they are sold by the personal efforts of the traveler, much of whose success is due as much to his personal qualifications as to the qualities of what he has to sell."

The Regulation of Electric-Power Plants.

WITH the advent of large electric power plants, especially for long-distance transmission and supply, many points require consideration to a degree not demanded in earlier and smaller installations. For this reason the paper of Mr. F. A. C. Perrine, recently presented before the Pacific Coast Electric Transmission Association, is of value at the present time and some abstracts are given.

The regulation of an electric plant is often thought to refer only to the maintenance of the proper voltage at the lamps or motors, but in actual practice many more things demand consideration. Assuming the supply to be an alternating current, the periodicity must be maintained constant, which means that a uniform speed must be maintained at the motive power, in this discussion assumed to be supplied by water-wheels. The system of regulation must, therefore, be capable of controlling the speed of the wheels, irrespective of changes in the load and changes in the voltage. In the generators the regulation is one of voltage, and this must vary with varying load, even though a constant voltage may be required by the customer. The amount of voltage variation to be provided by the generator is partly governed by the step-up transformers, while in the line will be found a disturbing element which must be considered. The final adjustment of the voltage must be made in the sub-station, where the step-down transformers are placed.

Considering first the water-wheels, the

method of regulating the speed varies according to the head of water. With large turbines, operating under a low head of water at a moderate velocity, the regulation can be effected by variation of gate opening, although this involves a variation in efficiency, such wheels being much less efficient at part-gate than at full-gate. Attempts to regulate bucket openings, instead of gate openings, in order to increase the efficiency at part load, have been made, but such have, as yet, not come into general use.

With a high head of water, and with the corresponding high velocities, any attempt to regulate by varying the flow of water produces fluctuations in the pressure which are most objectionable and even dangerous. The methods suggested by Mr. Perrine, and in practical use, are those of a deflecting nozzle, or a deflecting hood, it being understood that in such plants the wheels are of the impulse type, a jet striking upon suitably shaped buckets attached to the periphery of the wheel. To these methods Mr. Perrine suggests the advisability of dividing the power among a number of wheels, so that the general demand may be nearly supplied by the number of wheels put in action, and the extent of necessary regulation reduced to a minimum. To this excellent suggestion may be added the possibility of using a method of regulating in which the wheel is split into two halves in a plane normal to the axis, these halves separating or approaching, and thus offering a varying capacity to the jet, as the load varies.

Passing to the electrical portion of a plant, uniform speed at the water wheel being assured, the generator, operated at the constant speed of the water wheel, should be adapted for variable voltage regulation. Machines designed for self-regulation at constant voltage are not generally satisfactory on long-distance transmission plants. It is customary to measure the regulating properties of the generator on a non-inductive load, while in a long-distance transmission a non-inductive load is an impossibility, the lines and transformers introducing at the generator an inductance which must be taken care of by the design of the machine.

With regard to the transformers, they should be designed to relieve the machines

as far as possible of great necessity for variation as the inductive effect of the load changes. In consequence the specification of the inductive drop through a transformer is, in general, more important than a specification of the non-inductive regulation.

The line itself is perhaps the cause of the worst disturbing effect. Here we have not only an inductive drop, but also a heavy capacity current, the capacity current remaining practically constant at all loads while the inductive drop varies with the load. Reactance coils may be used to advantage at the sub-stations, not only to reduce the generator current and line loss at no load, but as sub-station voltage regulators.

In summing up, Mr. Perrine gives the following points as demanding careful consideration:

1. The sub-division of water-wheels, and the use of extremely high-speed machinery.
2. A wide range in the possible voltage variation in the generators, with generators and transformers both designed, not for good non-inductive load regulation, but for good inductive load regulation.
3. Lines designed for the smallest possible capacity current without reference to any attempt at balancing the line capacity against the load lag.
4. The use of reactance coils at the sub-station (instead of regulator heads on transformers) and wide range of regulators in feeder circuits.

Water Waste in New York.

THE question of the future water supply of New York City has been made the subject of two important reports, one presented by Mr. John R. Freeman to Comptroller Bird S. Coler, the other prepared by several engineers for the Merchants' Association. These reports are discussed very fully in a recent issue of *Engineering News*, from which some abstracts are made.

Both reports agree in the fact that New York is in danger of a disastrous water famine, unless active immediate steps are taken to secure a greater margin between the rapidly increasing demands for water and the available supply. The most important feature, however, is that this dan-

ger is shown to be very largely due to unwarranted and preventable waste.

The present consumption for Greater New York is 103 gallons per head per day, or 117 gallons for Manhattan and Bronx, and according to the studies of Messrs. Freeman, Croes, and Crowell, at least one-half of this is sheer waste. Of course other American cities are worse, notably Philadelphia, with its 200 gallons per head per day, but comparison with Philadelphia is hopeless, in view of the influences at work there.

The reports unite in showing the necessity of providing increased supply, but apart from increased supply comes the question of filtration, and unless the waste is restricted, and some reasonable limit placed upon the consumption, the cost of filtering the whole supply becomes prohibitory.

Mr. Freeman shows, by diagrams of the hourly consumption, that the minimum consumption in New York is never below 90 gallons per head per day, while in Fall River and Woonsocket, two cities in which meters are used, the minimum consumption is 5 gallons. In other words, each citizen of New York is charged with 90 gallons every day, which he does not and cannot use, and a large portion of which is flowing away while he sleeps. The comparison between New York and the above metered cities shows that the amount of water actually used is about the same in both cases, so that the introduction of meters works no hardship whatever, and does not cause any deprivation of water that could possibly be used.

Notwithstanding the evidence that a large proportion of New York's supply runs to waste, the advisory engineers despair of any permanent waste restriction being accomplished in the face of public opinion and official indifference. All that they appear to hope for is that such measures of restriction may be carried out to such an extent as will tide over the period needed to plan and construct new works.

These new works may draw their supply either from the Housatonic, or from the upper Hudson, but in either case they would involve the expenditure of immense sums of money and practically preclude the possibility of filtering the whole supply, as certainly should be done. In the meantime

the waste is to be permitted to go on, in deference to the utterly unwarranted belief that too much water cannot be supplied if a city is to be healthful and clean. By and by it may be understood that health and cleanliness depend more upon quality than quantity, and that too much foul water may be a thing most undesirable, and perhaps still later it may be realized that sufficient quantity and satisfactory quality might have been obtained without increasing the supply at all, simply by cutting off the preventable waste and filtering the used remainder.

There seems to be little use in retaining distinguished engineers when it is a foregone conclusion that their recommendations are either not to be followed, or else are to be so tempered to meet public and political opinion as to be materially affected in value. Far better to have a drastic denunciation of current waste than a foolish evasion of the real issue, and place the responsibility where it properly belongs.

American Permanent-Way Construction.

THE increased service demanded of American railways during the past few years has resulted in a general advance in the construction of the permanent way, and with this has also come a tendency toward standardization, which, although not complete, is sufficiently marked to demand consideration. In a recent issue of *Engineering News* a very complete set of tables is given, showing the comparative details of track construction throughout the United States, Canada, and Mexico, indicating clearly the present character of construction as adopted and now in force for new work and renewals; the list comprising forty-seven of the principal lines in all parts of the United States, the two great railway systems of Canada, and three railways in Mexico.

Three tables are given, the first containing data concerning standard rails, fastenings, and joints; the second, information about ties, tie-plates and ballast, and the third being devoted to frogs, switches, etc. With the tables are given notes of explanation, and there is also an editorial discussion of the whole subject.

The early diversity in practice was doubtless partly due to lack of intercourse be-

tween those having such work in charge, and one of the greatest benefits which has been conferred upon the engineering profession, not only in railway affairs, but in all branches of work, is the comparison of ideas and methods, rendering it possible for each to profit by the experience of all the others.

This tendency toward standardization, as a result of association, is well shown in the matter of rail sections, the type of section recommended by the rail committee of the American Society of Civil Engineers having been very extensively adopted. In many cases the new sections are not yet fully laid, but as they have been adopted and are being laid on all new work and renewals, they will enable standardization to proceed continuously. Heavier rails are naturally the rule, most of the main lines having rails of seventy-five and eighty pounds per yard, and greater lengths are coming into use, 33 feet being common, 45 feet on the Lehigh Valley and Reading roads, and in some special cases 60 foot rails being used.

There has been little progress made in fastenings, the old spike still being in general service, experiments with screw spikes not having been generally continued. Improvement in this direction is much needed, and an examination of European practice suggested.

"In regard to rail joints, the extent of track laid with suspended and broken joints far exceeds that laid with supported joints and square joints. Many roads are using various forms of bridge joints, and a few have adopted such a form as standard, but in most cases they are regarded mainly as experimental or merely incidental. Only three roads report the three-tie joint as standard, and only eight report the supported joint."

The important subject of ties is discussed as fully as the available data will permit, but the life of ties of nominally the same kind of timber varies for different parts of the country; oak from the south and south-

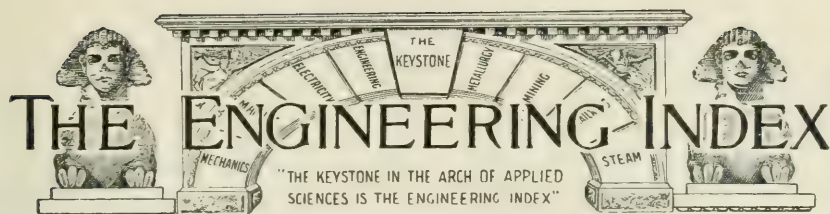
west has a life of six to seven years, while oak from the northern part of the country lasts from fourteen to sixteen years. Steel ties are used on the Mexican Inter-oceanic Railway, their estimated life being thirty years, and their cost \$2.25 in Mexican money.

Gravel ballast is more generally used than any other material, but stone is also extensively employed. Although the standard depth of ballast under the ties rarely exceeds twelve inches, the suggestion is made that a greater depth would be an advantage. The depth could readily be increased by raising the track and filling beneath.

In regard to frogs and switches, the bolted frog is in very general use. The old style plate frog is disappearing, but a combination type is in use in several cases, this consisting of rails bolted or clamped together and riveted to a base-plate. Spring rail frogs are almost universally used in main-line turnouts, only four or five roads still continuing to discountenance this type.

The objection may be on the ground of greater safety with the rigid frog, but in view of the experience with spring-rail frogs under the fastest and heaviest classes of traffic, this objection will hardly hold good. The split switch is now generally used, with either rigid or automatic switch-stands. On many important roads the main line turnouts are protected by distant signals, especially in cases where, owing to a curve or obstruction, the switch target cannot be seen at a distance by the engineer of an approaching train. The angles at the heels of frogs and switches are now generally provided with filling, so that a man's foot cannot get caught in the space below the rail head.

"Taken as a whole, the standards described in the tables show that the principal main lines, at least, have a sufficiently substantial form of track construction for the high-speed passenger trains and the enormously heavy freight trains which are now such a feature of American railway service."



The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language*; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of \$1.00; G, of \$1.20; and H, of \$1.60. In ordering, care should be taken to give the number of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for \$2.00, thirty-three for \$5, and one hundred for \$15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of *THE ENGINEERING MAGAZINE* at 10 cts. per month, or \$1.00 a year; to non-subscribers, 25 cts. per month, or \$3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: *Ill*—Illustrated; *W*—Words; *Anon*—Anonymous.

American Architect. *w*. Boston, U. S. A.
 American Electrician. *m*. New York.
 Am. Engineer and Railroad Journal. *m*. New York.
 American Gas Light Journal. *w*. New York.
 American Geologist. *m*. Minneapolis, U. S. A.
 American JI. of Science. *m*. New Haven, U. S. A.
 American Machinist. *w*. New York.
 Am. Manufacturer and Iron World. *w*. Pittsburg, U. S. A.
 American Shipbuilder. *w*. New York.
 Annales des Pontes et Chaussées. *m*. Paris.
 Architect. *w*. London.
 Architectural Record. *qr*. New York.
 Architectural Review. *s-q*. Boston, U. S. A.
 Architect's and Builder's Magazine. *m*. New York.
 Australian Mining Standard. *w*. Sydney.

Automobile Magazine. *m*. New York.
 Automotor & Horseless Vehicle JI. *m*. London.
 Brick Builder. *m*. Boston, U. S. A.
 British Architect. *w*. London.
 Brit. Columbia Mining Rec. *m*. Victoria, B. C.
 Builder. *w*. London.
 Bulletin Am. Iron and Steel Asso. *w*. Philadelphia, U. S. A.
 Bulletin de la Société d'Encouragement. *m*. Paris.
 Bulletin of Dept. of Labor. *b-m*. Washington.
 Bulletin of the Univ. of Wisconsin, Madison, U. S. A.
 Bull. Int. Railway Congress. *m*. Brussels.
 California Architect. *m*. San Francisco, U. S. A.
 Canadian Architect. *m*. Toronto.

- Canadian Electrical News. *m.* Toronto.
 Canadian Engineer. *m.* Montreal.
 Canadian Mining Review. *m.* Ottawa.
 Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
 Colliery Guardian. *w.* London.
 Compressed Air. *m.* New York.
 Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
 Consular Reports. *m.* Washington.
 Contemporary Review. *m.* London.
 Deutsche Bauzeitung. *b-w.* Berlin.
 Domestic Engineering. *m.* Chicago.
 Eclairage Electrique. *w.* Paris.
 Electrical Engineer. *w.* London.
 Electrical Review. *w.* London.
 Electrical Review. *w.* New York.
 Electrical World and Engineer. *w.* New York.
 Electrician. *w.* London.
 Electricien. *w.* Paris.
 Electricity. *w.* London.
 Electricity. *w.* New York.
 Elektrizität. *b-w.* Leipzig.
 Elektrochemische Zeitschrift. *m.* Berlin.
 Elektrotechnische Zeitschrift. *w.* Berlin.
 Elettricita. *w.* Milan.
 Engineer. *w.* London.
 Engineer. *s-m.* Cleveland, U. S. A.
 Engineers' Gazette. *m.* London.
 Engineering. *w.* London.
 Engineering and Mining Journal. *w.* New York.
 Engineering Magazine. *m.* New York & London.
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
 Fire and Water. *w.* New York.
 Foundry. *m.* Detroit.
 Gas Engineers' Mag. *m.* Birmingham.
 Gas World. *w.* London.
 Génie Civil. *w.* Paris.
 Gesundheits-Ingenieur. *s-m.* München.
 Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
 Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
 Horseless Age. *m.* New York.
 Ice and Refrigeration. *m.* New York.
 Indian and Eastern Engineer. *m.* Calcutta.
 Iron Age. *w.* New York.
 Iron and Coal Trades Review. *w.* London.
 Iron & Steel Trades Journal. *w.* London.
 Iron Trade Review. *w.* Cleveland.
 Journal Assn. Eng. Societies. *m.* Philadelphia, U. S. A.
 Journal of Electricity. *m.* San Francisco.
 Journal Franklin Institute. *m.* Philadelphia.
 Journal of Gas Lighting. *w.* London.
 Journal Royal Inst. of Brit. Arch. *s-gr.* London.
 Journal of Sanitary Institute. *gr.* London.
 Journal of the Society of Arts. *w.* London.
 Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
 Journal Western Soc. of Eng. *b-m.* Chicago.
 Journal of Worcester Poly. Inst., Worcester, Mass.
 L'Energie Electrique. *w.* Paris.
 Locomotive. *m.* Hartford, U. S. A.
 Locomotive Engineering. *m.* New York.
 Machinery. *m.* London.
 Machinery. *m.* New York.
 Marine Engineering. *m.* New York.
 Marine Review. *w.* Cleveland, U. S. A.
 Metal Worker. *w.* New York.
 Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
 Mines and Minerals. *m.* Scranton, U. S. A.
 Mining and Sci. Press. *w.* San Francisco, U. S. A.
 Mining Reporter. *w.* Denver, U. S. A.
 Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
 Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
 Modern Machinery. *m.* Chicago.
 Moniteur des Architects. *m.* Paris.
 Moniteur Industriel. *w.* Paris.
 Municipal Engineering. *m.* Indianapolis, U. S. A.
 National Builder. *m.* Chicago.
 Nature. *w.* London.
 Nature. *w.* Paris.
 Nautical Gazette. *w.* New York.
 New Zealand Mines Record. *m.* Wellington.
 Nineteenth Century. *m.* London.
 North American Review. *m.* New York.
 Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
 Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
 Ores and Metals. *w.* Denver, U. S. A.
 Plumber and Decorator. *m.* London.
 Popular Science Monthly. *m.* New York.
 Power. *m.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Soc. Civil Engineers. *m.* New York.
 Proceedings Engineers' Club. *gr.* Philadelphia, U. S. A.
 Proceedings St. Louis R'way Club. *m.* St. Louis, U. S. A.
 Progressive Age. *s-m.* New York.
 Railroad Car Journal. *m.* New York.
 Railroad Gazette. *w.* New York.
 Railway Age. *w.* Chicago.
 Railway & Engineering Review. *w.* Chicago.
 Review of Reviews. *m.* London & New York.
 Revue de Mécanique. *m.* Paris.
 Revue Gen. des Chemins de Fer. *m.* Paris.
 Revue Technique. *b-m.* Paris.
 Revue Universelle des Mines. *m.* Liège.
 Rivista Marittima. *m.* Rome.
 Sanitary Plumber. *s-m.* New York.
 Schweizerische Bauzeitung. *w.* Zürich.
 Scientific American. *w.* New York.
 Scientific Am. Supplement. *w.* New York.
 Stahl und Eisen. *s-m.* Düsseldorf.
 Stevens' Institute Indicator. *gr.* Hoboken, U. S. A.
 Stone. *m.* New York.
 Street Railway Journal. *m.* New York.
 Street Railway Review. *m.* Chicago.
 Telephone Magazine. *m.* Chicago.
 Tramway & Railway World. *m.* London.
 Trans. Am. Ins. Electrical Eng. *m.* New York.
 Trans. Am. Ins. of Mining Eng. *m.* New York.
 Trans. Am. Soc. of Civil Eng. *m.* New York.
 Trans. Am. Soc. of Heat & Ven. Eng. *m.* New York.
 Trans. Am. Soc. Mech. Engineers. *m.* New York.
 Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
 Transport. *w.* London.
 Western Electrician. *w.* Chicago.
 Wiener Bauindustrie Zeitung. *w.* Vienna.
 Yacht. *w.* Paris.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
 Zeitschrift für Elektrochemie. *w.* Halle a. S.
 Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Brickwork.

See Civil Engineering, Materials.

Chimneys.

See Mechanical Engineering, Steam Engineering.

Columns.

The Practical Column Under Central or Eccentric Loads. Continued discussion of paper by J. M. Moncrieff. 2000 w. Pro Am Soc of Civ Engs—Aug., 1900. No. 36095 E.

Dock Offices.

The Liverpool Dock Offices. Illustrations, with report and estimate, of plans which obtained the second prize in the recent competition. 6500 w. Archt, Lond—Aug. 3, 1900. No. 35795 A.

Factory.

A Steel-Concrete Factory Building. Illustrated description of a 125 x 135-ft., 2-story building, having a steel framework and walls and roof of concrete. 800 w. Eng Rec—Aug. 25, 1900. No. 36087.

Fire-Proof.

Fire-Proof Construction in North America (*Feuerfeste Bauausführungen in Nordamerika*). Karl Riensberg. A well illustrated account of methods of fire-proof construction and materials used, principally in the high buildings of New York. Serial. 1st part. 4500 w. Stahl und Eisen—July 15, 1900. No. 35888 D.

Floors.

Reinforcing a Warehouse Floor. Illustrated description of a method of strengthening floors by means of king post trusses. 600 w. Eng Rec—Aug. 25, 1900. No. 36090.

Foundations.

Pneumatic Foundations in New York. Illustrates and describes recent work where cylindrical wooden caissons were used with speed and success. 700 w. R R Gaz—Aug. 17, 1900. No. 35973.

Girders.

See Civil Engineering, Construction.

High Buildings.

Height of Buildings. An informal discussion by Corydon T. Purdy and Reginald Pelham Bolton. Ill. 2500 w. Pro Am Soc of Civ Engs—Aug., 1900. No. 35097 E.

Joints.

Joints and Joinery. Fred T. Hodson. Illustrates and describes various kinds of

joints. 1700 w. Arch & Builds' Mag—Aug., 1900. Serial. 1st part. No. 35743.

Office Building.

The Atlantic Mutual Insurance Company's Building. Illustrated description of the special pneumatic caisson foundations, cantilever column seats, and special steel work details in an 18-story office building on Wall st., New York. 3100 w. Eng Rec—Aug. 18, 1900. No. 36030.

The Bittenweiser Building, New York. Illustrated description of the special foundations and steel work details in an 11-story office building. 1100 w. Eng Rec—Aug. 4, 1900. No. 35724.

Paris Exposition.

The Exposition Palaces on the Esplanade des Invalides (Exposition de 1900. Les Palais de l'Esplanade des Invalides). Louis David. A well illustrated description of the Palace of Manufactures and the neighboring buildings, and their construction with a steel skeleton. 3000 w. 1 plate. Génie Civil—Aug. 4, 1900. No. 35884 D.

Roof Truss.

A Large Wooden Roof Truss. Illustrated description of the details of a 67-ft. truss for a large warehouse in Brooklyn. 600 w. Eng Rec—Aug. 18, 1900. No. 36029.

Staircases.

Spiral Staircases. W. and A. Mowat. From *The Stone Trades Journal*, England. Illustrated account of early construction, improvements, etc. 1700 w. Stone—Aug., 1900. No. 36100 C.

Tenements.

Low Rental Block Dwellings. A statement from several papers before the R. I. B. A. on the theoretically best arrangement of tenements, with notes on model buildings in several cities. 1600 w. Eng Rec—Aug. 11, 1900. No. 35756.

Theatre.

The Folly Theatre, Brooklyn. Illustrated description of the general arrangement and special steel work of a 100 x 150 ft. theatre, the first constructed under the New York building laws. 2000 w. Eng Rec—Aug. 11, 1900. No. 35757.

HEATING AND VENTILATION.

Artificial Heating.

Artificial Heating. W. M. Watson. The subject is viewed from the standpoint of the fitter, and discusses various systems.

Ill. 3200 w. Can Engr—Aug., 1900. Serial. 1st part. No. 35785.

Greenhouse.

A Modern Greenhouse Heating Plant. From *The Florists' Exchange*. Illustrates and describes the plant in a mammoth greenhouse establishment at Cromwell, Conn. 2000 w. Met Work—Aug. 18, 1900. No. 35962.

Hot-Water.

Low Pressure Hot-Water Heating. J. Nelson Russell. Read at meeting of Inst. of Heat and Ven. Engs., London. Considers this system efficient, easily attended to and economical. 2100' w. Met Work—Aug. 11, 1900. No. 35778.

Metropolitan Museum.

Ventilation and Heating in the Metropolitan Museum of Art, New York. Illustrated description of a plant designed to show no source or method of heating to the observer. Fresh tempered air is forced through hidden direct radiators. 2200 w. Eng Rec—Aug. 18, 1900. No. 36031.

Steam Heating.

Steam Heating in a Tall Brooklyn Office Building. Illustrated description of a plant in a 14-story building, which will utilize the exhaust from the power plant for heating purposes. Special consideration was given to the design of the pipe work. 1700 w. Eng Rec—Aug. 4, 1900. No. 35725.

PLUMBING AND GAS FITTING.

Hot Water.

A Multiple Hot Water Supply. Illustrated description of an unusually complex system of plumbing for water supply in a large New York residence. 1500 w. Eng Rec—Aug. 11, 1900. No. 35759.

Domestic Hot Water Supply. Frederick Dye. Read at London meeting of the Inst. of Heat and Ven. Engs. An illustrated account of what happens when a tap is opened, and allied phenomena. 2500 w. Plumb & Dec—Aug. 1, 1900. No. 35794 A.

House Drainage.

A Model System of Plumbing. William

S. MacHarg. Practical conclusions on the subject of house drainage, drawn from the writer's experience. 3000 w. Dom Engrg—Aug. 15, 1900. No. 36058 C.

Some Thoughts on House Drainage. Robert Smeaton. A discussion of the essentials to a perfect system. 1400 w. Dom Engrg—Aug. 15, 1900. No. 36057 C.

Mechanical Plant.

The Sanitary Equipment and Power Plant of a Modern Lodging House. Illustrated detailed description of these features in Mills Hotel, No. 1, New York City. 2800 w. Sci Am Sup—Aug. 11, 1900. No. 35932.

Sewerage.

See Civil Engineering, Municipal.

Superintendence.

The Superintendence of Sanitary, Hydraulic and Gas-Piping Work in Buildings. William Paul Gerhard. Discusses points intended as a help in such work. 3000 w. Archts & Builds' Mag—Sept., 1900. Serial. 1st part. No. 36142.

MISCELLANY.

Marble.

The Marble of Laas (Der Laaser Marmor). Heinrich Lenz. An illustrated description of a Tyrolese marble quarry and methods of working it. The marble is particularly adapted for artistic purposes. Serial. 2 parts. 3500 w. Wiener Bauindustrie Zeitung—July 26, Aug. 2, 1900. No. 36154 each D.

Pan-American Exposition.

Views of the Pan-American Exposition. Illustrates the Park Lake, the North Bay, the art palace, and the New York State building, with brief descriptions. 1700 w. Sci Am Sup—Aug. 4, 1900. No. 35651.

Twentieth Century House.

The House of the Twentieth Century (La Maison du XXe Siècle). A somewhat fanciful theoretical discussion of a house with all modern improvements, built on scientific and hygienic principles. Serial. 2 parts. 7000 w. Revue Technique—May 25, June 25, 1900. No. 35829 each D.

CIVIL ENGINEERING

BRIDGES.

Alexander III.

Engineering at the Paris Exposition of 1900 (Das Ingenieurwesen auf der Pariser Weltausstellung des Jahres 1900). Fritz Eiselen. An illustrated description of this highly artistic highway bridge, and its construction. Serial. 1st part. 2000 w. Deutsche Bauzeitung—July 14, 1900. No. 35801 B.

Cantilever.

A Cantilever Concrete Sidewalk. Illustrated description of a 5-ft. sidewalk carried on Hennibique concrete-steel brackets projecting from the face of a retaining wall. 500 w. Eng Rec—Aug. 4, 1900. No. 35718.

Economy.

Economy in Bridge Work. Editorial discussion of the need of radical changes

in the English method of bridge design. 2400 w. Engng—Aug. 3, 1900. No. 35-905 A.

Foot-Bridge.

Steel Arch Foot-Bridge Over the Seine at Paris. Illustrated description. 500 w. Eng News—Aug. 30, 1900. No. 36145.

German Bridges.

German Bridge-Building. Exhibits at the Paris Exhibition. An account of the exhibits of the six leading German firms devoted to the design and construction of metallic bridges. 3200 w. Engng—Aug. 10, 1900. Serial. 1st part. No. 36-006 A.

Highway.

Comparative Estimates of the Cost of Combination and All-Steel Highway Bridges. H. G. Tyrrell. Shows that in the bridge in question the combination bridge cost one-third less than the steel one. 300 w. Eng. News—Aug. 23, 1900. No. 36065.

The Wellsville Over-Grade Bridge. Illustrated description of a light highway bridge, affording a clearance of 22 ft. over the rail base, with the floor surface only 23 ft. above the base. 600 w. Eng Rec—Aug. 4, 1900. No. 35717.

Improvements.

Bridge Improvements on the Bangor and Aroostook R. R. Illustrations, with brief description. 800 w. Ry & Engng Rev—Aug. 11, 1900. No. 35925.

Plate Girder.

Plate Girder Park Foot-Bridge at Madison, N. J. Illustrated description. 200 w. Eng News—Aug. 23, 1900. No. 36-068.

Railway Bridges.

The Bridge Work of the Pittsburg, Bessemer & Lake Erie and Union Railways. Illustrated descriptions of details and features of novelty. 4300 w. Eng News—Aug. 16, 1900. No. 35963.

Suspension.

Note on a New Type of a Rigid Suspension Bridge (Note sur un Nouveau Type de Pont Suspendu Rigide). M. Gisclard. A description, with diagrams, of a suspension bridge, stiffened by two trusses hinged at the center. Serial. 1st part. 2800 w. Ann d Ponts et Chaussées—4th quarter, 1899. No. 35851 E + F.

Viaduct.

The Riverside Drive Viaduct, New York. Illustrated description of a viaduct 1,800 ft. long and 80 ft. wide, consisting of short masonry approaches, a 130-ft. steel arch, three of 18 ft., and twenty-two of 65 feet. The article illustrates all the special details of both masonry and steel work. 3800 w. Eng Rec—Aug. 25, 1900. No. 36083.

Vienna.

The Franzeus Bridge at Vienna. Illustrated translation of article, by F. Pfeuffer, on an arch highway bridge, giving his views on the æsthetic considerations governing bridge design. 2600 w. Eng Rec—Aug. 18, 1900. No. 36028.

CONSTRUCTION.

Arched Ribs.

A Simple Method of Calculating the Curve of Equilibrium, or Line of Thrust, in Arched Ribs. Charles Leon. The method is explained by illustrations of the cases which may occur in practice. 1800 w. Engr, Lond—Aug. 3, 1900. No. 35-912 A.

Columns.

See Architectural Engineering, Construction.

Excavators.

Smulder's Excavators. Illustrated description of some interesting exhibits at the Paris Exposition. 1300 w. Engng—Aug. 3, 1900. No. 35904 A.

Foundations.

See Architectural Engineering, Construction.

Girders.

Counterbracing Girders. Considers the two methods usually adopted for counterbracing the open webs of trusses and girders. 2000 w. Engr, Lond—July 27, 1900. No. 35739 A.

The Depth of Girders. Discusses the conditions and economic depth of girders. 2300 w. Engr, Lond—Aug. 17, 1900. No. 36109 A.

Groined Arch.

Diagram for Determining the Volume of Semi-Elliptical Groined Arch Vaulting. John H. Gregory. Gives a diagram for simplifying the mathematical work, with explanation. 350 w. Eng News—Aug. 23, 1900. No. 36063.

Lighthouses.

The Evolution of Lighthouses (Die Konstructive Entwicklung der Seefeuer). M. Geitel. A paper before the Verein Deutscher Maschinen-Ingenieure, giving an illustrated account of the historical and technical development of lighthouses; based on a forthcoming book by Veitmeyer. Serial. 2 parts. 15000 w. Glasers Annalen—July 15, Aug. 1, 1900. No. 35877 each D.

Masonry.

The Injection of Cement, by Means of Compressed Air, into Masonry Structures (Note sur l'Emploi d'Injection de Ciment à l'Air Comprimé dans les Maçonneries, Terrains de Fondations, etc.) M. Caméré. An illustrated description of an apparatus and the method used for pre-

venting cracks in masonry, with results of experiments. 1500 w. Ann d Ponts et Chaussées—1st quarter, 1900. No. 35863 E + F.

Piles.

A Hydraulic Screwing Machine for Driving Screw Piles. Charles William Anderson. Abstract of a paper presented to the Institution of Civ. Eng. Describes the machine and its operation under varying conditions. 1000 w. Eng News—Aug. 9, 1900. No. 35944.

Roads.

Note on the Maintenance of the French National Highways (Note sur l'Aménagement de l'Entretien des Routes Nationales par Rechargements Cylindrés et sur les Resultats Obtenus dans l'Arrondissement du Sud du Departement des Ardennes). M. Perrin. An account of the system followed, with tables. 3000 w. Ann d Ponts et Chaussées—1st quarter, 1900. No. 35861 E + F.

Roof Truss.

See Architectural Engineering, Construction.

Tunnels.

The Machinery Employed and Methods of Construction Adopted at the Simplon Tunnel. Charles Beresford Fox. Abstract of a paper read before the Inst. of Civ. Eng. of Gt. Britain. An account of the undertaking, with description of constructive details. 6500 w. Eng News—Aug. 30, 1900. No. 36147.

Some Tunnel Re-Construction on the Baden State Railways (Ueber einige Tunnel-Umbauten auf den Grossh. Badischen Staats-Eisenbahnen). J. Rosshändler. An illustrated account of the rapid repairing and enlargement of three tunnels, without interrupting traffic. 1100 w. Deutsche Bauzeitung—June 23, 1900. No. 35800 B.

Wind Pressure.

Wind Pressure (Winddruck). R. Kohfahl. A general discussion of the subject, with illustrations, diagrams and tables. 5000 w. Zeitschr d Ver Deutscher Ing—Aug. 4, 1900. No. 35874 D.

HYDRAULIC AND WATER SUPPLY.

Canals.

A Waterway 4,000 Kilometers Long between the Baltic and Caspian Seas (De la Mer Baltique à la Mer Caspienne; une Voie de Navigation de 4,000 Kilomètres). MM. Suquet and Fontaine. An account of a canal system between St. Petersburg and the Volga River, and improvements of the latter, with map and illustrations. 25000 w. 1 plate. Ann d Ponts et Chaussées—1st quarter, 1900. No. 35856 E + F.

Canal between the Marne and Saone Rivers. France (Canal de la Marne a la

Saone). Gustave Cadart. A full description of the canal, 151 kilometers long, though not yet finished, with maps, plans and illustrations. 21000 w. 4 plates. Ann d Ponts et Chaussées—4th quarter, 1899. No. 35849 E + F.

Final Report of the Special Commission on the Chicago Drainage Canal. Abstract of the final reports recently issued. 2400 w. Eng News—Aug. 9, 1900. No. 35946.

Coffer Dam.

Partial Failure of Coffer Dam, New Dry Dock, Boston Navy Yard. Frank O. Maxson. Illustrated description of the failure of a coffer dam over 40 ft. high and 36 ft. wide. 2000 w. Eng Rec—Aug. 4, 1900. No. 35716.

Conduit.

Experimental Test of a Concrete and Expanded Metal Conduit for the Jersey City Water Supply. R. Godfrey. Illustrated description of the section designed and tested. 700 w. Eng News—Aug. 30, 1900. No. 36143.

Filtration.

Filtration of Water for Public Use. By Rudolph Hering, Philip H. Palmer, and E. Perrett. An informal discussion of the processes in use, their sanitary effect, cost, and reliability. 3300 w. Pro Am Soc of Civ Engs—Aug., 1900. No. 36099 E.

Graded Filters for Large Quantities of Water (Filtres Degrossisseurs pour Grandes Masses D'Eau). A. Puech. An illustrated description of filters in which the water passes successively through beds of gravel which at first is rough and grows finer and finer. 3400 w. Mem d l Soc d Ing Civils de France—Nov. 10, 1900. No. 35844 G.

The Filtration of Water for Public Use. Résumé of a discussion at the London meeting of the Am. Soc. of Civ. Engs. 4000 w. Jour Gas Lgt—July 24, 1900. No. 35653 A.

The Marlborough Brook Filter Beds; Metropolitan Water Supply for Boston and Vicinity. Brief account of these beds, the cost of construction, etc. 1000 w. Eng News—Aug. 30, 1900. No. 36148.

Flow.

On the Flow of Water Over Dams. Continued discussion of paper by George W. Rafter. 6000 w. Pro Am Soc of Civ Engs—Aug., 1900. No. 36094 E.

Harbors.

Harbors of Tunis (Les Ports Tunisiens). G. Leugny. A well illustrated account of harbor improvements at Tunis and Sousse, in Tunis, with tables showing amount of traffic and port charges. 3000 w. Revue Technique—July 25, 1900. No. 35837 D.

Irrigation.

Irrigation in the United States. Elwood

Mead. Describing the influences which retard the development of irrigation works in the United States. 2200 w. Eng Rec—Aug. 25, 1900. No. 36086.

Lake Levels.

The Changes of the Great Lake Levels. From *Chicago Inter-Ocean*. Comments on the changes in level and the effect of the drainage canal on Lake Michigan. 1400 w. Am Archt—Aug. 4, 1900. No. 35705.

Measurement.

Water Measurement and Manipulation in Colorado. H. A. Crafts. Illustrations with description of the method of distributing water for irrigation purposes. 1600 w. Sci Am—Aug. 11, 1900. No. 35929.

Resistance.

The Resistance of Immersed Bodies and Application of the "Sine Square" Formula (*Résistance des Carènes, Essais de Joëssel et Formule du "Sinus Carré"*). A. Duroy de Bruignac. An illustrated description of experiments to determine the pressure on surfaces immersed in running water, and discussion of formulæ; with tables. 4000 w. Mem d l Soc d Ing Civils de France—No. 12, 1900. No. 35846 G.

River Improvement.

A Discussion on the Protection of River Banks (*Vereins-Angelegenheiten. Einleitung zu einer Besprechung über Ufer-versicherungen*). Paul Klunzinger. An address before a branch of the Oest. Ing. und Arch. Verein, giving an illustrated description of various methods of construction. 3000 w. Zeitschr d Oest Ing u Arch Ver—July 20, 1900. No. 35894 B.

On the Regulation of Rivers (*Ueber Flussregulirungen*). Ignaz Pollak. A general discussion of the improvement of rivers, tending to show that mere straightening is not effective; with diagrams. 7000 w. Zeitschr d Oest Ing u Arch Ver—Aug. 3, 1900. No. 35895 B.

The Improvement of the South Pass of the Mississippi River. William Starling. Map with description of the delta and passes, and full account of work on the South Pass. 10000 w. Eng News—Aug. 23, 1900. No. 36059.

The Relation between the Configuration of the River Bed and the Depth of the Channel in the Lower Schelde, Belgium (*Hydraulique Fluviale. Etude sur la Corrélation entre la Configuration du Lit et la Profondeur du Chenal dans l'Escaut Maritime*). M. Fargue. It was found that the depth was greatest where the concavity of the curves was sharpest. Illustrated by maps and diagrams. 2800 w. 2 plates. Ann d Ponts et Chaussées—1st quarter, 1900. No. 35855 E + F.

The Moselle Canal Day in Metz (*Der Moselkanaltag in Metz*). Projects for the improvement of the Moselle River, so as

to make it navigable up to Metz, discussed at a meeting of the Verband für Kanalisierung der Mosel und Saar. 5500 w. Stahl und Eisen—Aug. 1, 1900. No. 35891 D.

Sterilization.

The Sterilization of Drinking Water (*La Sterilisation des Eaux Alimentaires*). Albert Bergé. An illustrated description of a sterilizing process in which chlorine peroxide is used, any excess of the latter being afterward removed by filtering through coke. 2800 w. Mem d l Soc d Ing Civils de France—No. 11, 1900. No. 35845 G.

Water Pollution.

The Bacteriology of Soils with Reference to the Pollution of Water. A review of investigations for the British Local Government Board, showing that the presence of certain innocuous bacteria in drinking water, taken in connection with other facts, may be of aid in determining its sanitary quality. 1400 w. Eng Rec—Aug. 11, 1900. No. 35758.

The York Water Pollution Case. A review of the decision of the Pennsylvania Supreme Court in *Commonwealth v. Yost*, restricting the powers of the State Board of Health and refusing to approve the criminal prosecution by a private corporation without powers of eminent domain against anyone polluting its source of supply. 1300 w. Eng Rec—Aug. 11, 1900. No. 35751.

Water Power.

The Utilization of the Yonne River for Supplying the Town of Chateau-Chinon, France, with Drinking Water and Electric Light (*Notice sur l'Adduction des Eaux de l'Yonne pour l'Alimentation de Chateau-Chinon et l'Eclairage Electrique de la Ville*). MM. Pochet and Assy. An illustrated description of the work, comprising dam, power plant, aqueduct, reservoir, etc. 4000 w. 1 plate. Ann d Ponts et Chaussées—1st quarter, 1900. No. 35857 E + F.

Water Purification.

Operation of the Water Settling and Filtration Plant at Albany, N. Y. Gives results of nearly a year's operation of this plant. 1700 w. Eng News—Aug. 9, 1900. No. 35942.

Purification and Filtration of Drinking Water for the Paris District (*Epuraton et Filtration des Eaux d'Alimentation de la Banlieue de Paris*). MM. Veilhan and Regnard. A general description of the Anderson process, and the results achieved. 4000 w. Ann d Ponts et Chaussées—1st quarter, 1900. No. 35859 E + F.

The Removal of Iron from Water (*Die Enteisung des Grundwassers*). G. Oesten. A paper before the Berlin branch of the Verein Deutscher Ingenieure, giving an illustrated description of methods

of removing iron from spring and well water, principally by aeration and filtration. 4000 w. *Zeitschr d Ver Deutscher Ing*—July 28, 1900. No. 35872 D.

Water Supply.

Report of the Merchants' Association on the Water Supply of Greater New York. Gives reports of committees appointed to investigate the whole subject of the present and future supply. 9000 w. *Eng News*—Aug. 23, 1900. No. 36069.

The Merchants' Association Report on the New York Water Supply. A statement of the conclusions reached by a committee of 33 representatives of engineering, legal, and business interests, concerning the best method, financial and from an engineering standpoint, of supplying New York with water for the next 40 years. 2700 w. *Eng Rec*—Aug. 25, 1900. No. 36082.

The Water Waste and Future Water Supply of Greater New York. Editorial on the information given in the reports of the Merchants' Assn., and of John R. Freeman. 2300 w. *Eng News*—Aug. 23, 1900. No. 36062.

Water Waste.

The Ratio of Water Wasted to That Used. A letter from C. Baillaigé, describing experiments to determine water waste in Quebec. 700 w. *Eng Rec*—Aug. 18, 1900. No. 36033.

Water-Works.

Godalming Water-Works. An account of the conditions in an English town, and the means taken to increase the supply. 2000 w. *Engng*—Aug. 3, 1900. Serial. 1st part. No. 35903 A.

New Water-Works Extension in Glasgow. J. A. Stewart. Brief illustrated account of an extension of more than local importance, to cost \$5,000,000. 1200 w. *Sci Am Sup*—Aug. 18, 1900. No. 36014.

The Little Falls, Minn., Water Contract. The full text of a decision of the U. S. Circuit Court, denying the right of cities to abrogate long-time franchise contracts on the ground of excessive rates, without positively proving the charges to be exorbitant. 2500 w. *Eng Rec*—Aug. 25, 1900. No. 36089.

The Rate of Water Consumption. Illustrated review of an analysis, by John R. Freeman, of the hourly rate of consumption in New York, Brooklyn, Woonsocket, Fall River, and Providence, showing that the variations are practically uniform in all these cities. 1700 w. *Eng Rec*—Aug. 4, 1900. No. 35720.

The Water-Works of Leighton Buzzard, England. Illustrated description of a plant noteworthy for a water tower with a gas engine pumping plant within its base. The tank is arranged so as to partly eliminate the iron salts dissolved in

water. 1200 w. *Eng Rec*—Aug. 25, 1900. No. 36084.

The White Plains Water-Works. Illustrated description of a low masonry dam, a unique method of increasing ground water supplies, by the run-off from an adjacent catchment area and a special standpipe valve. 2700 w. *Eng Rec*—Aug. 25, 1900. No. 36085.

MATERIALS.

Brickwork.

Bricks and Brickwork in Engineering Construction. Review of a lecture by Dr. A. C. Elliott, delivered to the Brit. Assn. of Water-Works Eng., on the "Strength of Brick and Brickwork." 1500 w. *Jour Gas Lgt*—July 31, 1900. No. 35788 A.

Cement Tests.

Relations Between Physical and Chemical Tests of Cement. An abridgement of a report by Otto H. Klein and S. F. Peckham to the New York Commissioners of Accounts. Gives a new scheme of cement analysis that claims to establish a law of correspondence between the physical properties and chemical composition of cement. Also editorial. 5400 w. *Eng Rec*—Aug. 4, 1900. No. 35721.

Relations Between Physical and Chemical Tests of Cement. A letter from Chas. F. McKenna, discussing new methods of analysis recommended in a report of the Commissioners of Accounts of New York City, and printed in the *Eng. Rec.* of Aug. 4. 1600 w. *Eng Rec*—Aug. 18, 1900. No. 36032.

Testing Cement by the Modulus of Rupture for Transverse Strain. John Pater-son. A summary of results of experiments for ascertaining the modulus of rupture, and some of the conclusions. 5000 w. *Engr, Lond*—Aug. 10, 1900. No. 36009 A.

Corrosion.

See Mining and Metallurgy, Iron and Steel.

Reinforced Concrete.

Experiments on the Action of Sea Water upon Concrete-Steel (*Expériences sur l'Alteration des Ciments Armés par l'Eau de Mer*). M. Lidy. Experiments which show that electrolytic actions take place, which cause deterioration of the steel or iron. 2200 w. *Ann de Ponts et Chaussées*—4th quarter, 1899. No. 35853 E + F.

The Resistance of Materials (*Résistance des Matériaux*). A theoretical discussion, with particular reference to concrete-iron construction. Serial. 1st part. 1400 w. *Revue Technique*—June 25, 1900. No. 35833 D.

Spanish Laboratory.

The Madrid Engineering Laboratory (*Le Laboratoire du Matériel du Génie à*

Madrid). M. Mesnager. A short account of a military engineering laboratory at Madrid, for testing materials, etc., with plan, abstracted from a report of the director, Col. J. Marva y Mayer. 500 w. *Ann d Ponts et Chaussées*—1st quarter, 1900. No. 35862 E + F.

Testing.

The International Congress of Testing Materials of Construction. Briefly reviews papers of A. L. Colby, Henry M. Howe, and W. R. Webster. 6200 w. *Ir Age*—Aug. 9, 1900. No. 35923.

Timber.

The Influence on the Quality of Timber of the Time When It Is Felled (*Ueber den Einfluss der Fällungszeit auf die Qualität der Nutz-und Bauhölzer*). H. Schiller-Tietz. A discussion of the physical and chemical changes that occur in timber at different seasons, and the best time for cutting. 2000 w. *Deutsche Bauzeitung*—July 14, 1900. No. 35802 B.

Timber Preservation.

A Proposed Method for the Preservation of Timber. Discussion of paper by F. A. Kummer. 4000 w. *Pro Am Soc of Civ Engs*—Aug., 1900. No. 36096 E.

The Preservation of Timber. A statement of recent suggestions regarding methods of preserving timber, and a hint concerning the reason that treated timber ties last longer in Europe than in the United States. 1000 w. *Eng Rec*—Aug. 18, 1900. No. 36024.

The Rapid Seasoning and Fireproofing of Timber by Electricity (*La Sénilisation Rapide et L'Ignifugation des Bois par L'Electricité*). G. Leugny. An illustrated description of a method of impregnating timber with preservative and fireproofing salts by electrolytic action. 3000 w. *Revue Technique*—June 10, 1900. No. 35830 D.

Z-Bar Stresses.

The Stresses in the Edges of Z-Bars (*Die Randspannungen in Z-Eisen*). H. Roskoth. A paper before the West Prussian branch of the Verein Deutscher Ingenieure, containing a mathematical discussion of the subject, with diagrams. 2500 w. *Zeitschr d Ver Deutscher Ing*—Aug. 4, 1900. No. 35875 D.

MUNICIPAL.

Cesspools.

The Cesspool. Leonard P. Kinnicutt. From an address before the Mass. Assn. of Boards of Health. A comparison of primitive and modern methods of treating sewage. 3200 w. *Munic Engng*—Aug., 1900. No. 35656 C.

Municipal Plants.

Municipal and Private Ownership of Water, Gas and Electric Light Plants in

the United States. Editorial discussion of the report just published by the U. S. Dept. of Labor. 4000 w. *Eng News*—Aug. 9, 1900. No. 35945.

Paris Exhibition.

Municipal Engineering Exhibits at the Paris Exposition. Describes exhibits of interest, especially the display made by the city of Paris. Ill. 2000 w. *Eng News*—Aug. 2, 1900. No. 35690.

Pavements.

A Defense of Australian Hard-Wood Pavements. From a pamphlet by Sir Edward H. Wittenoom, in reply to disparaging remarks made by D. J. Ross. 2500 w. *Eng News*—Aug. 23, 1900. No. 36061.

Tar-Macadam Pavement in Ontario. Information concerning a pavement recommended for excellence, durability, and cheapness. 600 w. *U. S. Cons Repts*, No. 815—Aug. 23, 1900. No. 36051 D.

The Action of Water on Asphalt Pavements. Daniel B. Luten. An account of a series of experiments made by the writer, and the conclusions drawn. 2600 w. *Eng News*—Aug. 16, 1900. No. 35966.

Sewage Disposal.

Bacterial Sewage Disposal During the Past Year. George Thudichum. A paper read before the Assn. of Mun. and Co. Engs., reviewing the details in which improvements have been made; with an abstract of the discussion. 6300 w. *Eng Rec*—Aug. 11, 1900. No. 35754.

Septic Sewage Disposal at Liberty, N. Y. Illustrated description of a plant to dispose of the sewage of a resort where land for filtration was unobtainable. 1200 w. *Eng Rec*—Aug. 18, 1900. No. 36025.

Sewage and Garbage Disposal in China. Reports by John Fowler and J. W. Ragsdale, U. S. Consuls at Chefoo and Tientsin. 1000 w. *Eng Rec*—Aug. 11, 1900. No. 35755.

The Indiana Sewage Disposal Law. Analysis of the decision of the Supreme Court of Indiana, permitting the pollution of streams by the sewage from towns, but forbidding it in the case of sewage of industrial establishments. 2600 w. *Eng Rec*—Aug. 4, 1900. No. 35715.

The Management of Sewage Farms. A statement, by H. Royle, of the methods employed in Stretford to prevent land sickness and yield good effluents. 1900 w. *Eng Rec*—Aug. 4, 1900. No. 35723.

The New Jersey Sewage Disposal Law. A discussion by James Owen, of the law prohibiting the pollution of New Jersey streams after 1904. 1800 w. *Eng Rec*—Aug. 4, 1900. No. 35719.

The Purification of Trade Wastes. W. O. E. Meade-King. Abstract of a paper before the Inst. of C. E., describing experiments to determine satisfactory methods of purifying waste liquors from

various industrial establishments. 4400 w. Eng Rec—Aug. 25, 1900. No. 36088.

Sewage Farms.

The Healthfulness of Milk from Dairies on English Sewage Farms. Interesting information given in a recent report of Frederick W. Andrews, to the Secretary of State for War. 1000 w. Eng News—Aug. 16, 1900. No. 35967.

Sewerage.

The Principles of Drainage and Sewerage. A discussion of the principles that should govern the construction, with some consideration of cost. 2800 w. Dom Engng—Aug. 15, 1900. No. 36056 C.

Sewers.

The Main Sewers of Dijon, France (Les Grands Collecteurs de la Ville de Dijon). Charles Mocquery. A full and well illustrated description of the Dijon sewer system. 25000 w. 6 plates. Ann d Ponts et Chaussées—1st quarter, 1900. No. 35854 E + F.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

French Cable Projects. From the report of the commission appointed to examine the question of a system of submarine telegraph lines to connect certain colonies with the mother country. A map showing the proposed lines is given. 1600 w. Elect'n, Lond—Aug. 10, 1900. No. 35998 A.

French Submarine Telegraphy (La Télégraphie Sous-Marine en France). H. Casevitz. A general review of the subject, including cables, ships, laying and grappling for cables; with tables of comparative statistics, and maps showing cables of world. 10000 w. 1 plate. Mem d l Soc d Ing Civils de France—No. 7, 1900. No. 35838 G.

Insulated Cables at the Paris Exhibition. Comments on the exhibits, noting the great extension of the employment of fibrous materials in place of rubber and gutta-percha. 3200 w. Engng—July 27, 1900. No. 35733 A.

Electrical Apparatus.

The Exhibit of Electrical Novelties at Kiel (Die Ausstellung Elektrotechnischer Neuheiten in Kiel). Alfred A. Reimer. An illustrated description of various electric appliances for marine use, particularly telegraph indicators, exhibited on the occasion of the annual meeting of the Verband Deutscher Elektrotechniker. 2500 w. Schiffbau—July 23, 1900. No. 35825 D.

Streets.

The Evolution of City Streets. Williston Fish. Discusses the importance of roads, with suggestions for street car development in serving cities. 4800 w. St Ry Rev—Aug. 15, 1900. No. 35993 C.

Trade Wastes.

The Purification of Trade Wastes. Abstract of a description by R. A. Tatton, before the Inst. of C. E., of methods of treating soap and dye waters from manufacturing establishments in the Mersey and Irwell district. 1800 w. Eng Rec—Aug. 18, 1900. No. 36026.

MISCELLANY.

Education.

Some Considerations Affecting the Training of Young Engineers. W. C. Borrowman. On the educational requirements and means of meeting them. Also discussion. 20000 w. Trans of N. E. Coast Inst of Engs & Shipbuilders—June, 1900. No. 35986 F.

Long Distance.

Prof. Pupin's Proposed System for Long-Distance Telephoning. H. T. Wade. Discusses the results attained in long-distance telephoning and increase in rate of speed in the operation of ocean cables. 2300 w. Eng News—Aug. 23, 1900. No. 36067.

Printing Telegraph.

The Kübler Printing Telegraph (Typendruck von Kübler). An illustrated description of a step-by-step printing telegraph apparatus with a very simple transmitter. 800 w. Elektrotech Zeitschr—July 19, 1900. No. 35806 B.

Ship Telegraph.

The New Electric Telegraph Signal Apparatus of the Allgemeine Elektrizitäts Gesellschaft on the Rotary Field Indicator System (Die Neuen Elektrischen Kommandoapparate der Allgemeinen Elektrizitäts Gesellschaft nach dem "Drehfeldfernzeiger-System"). F. Querengässer. A paper before the Verband Deutscher Elektrotechniker, giving an illustrated description of an apparatus for transmitting signals and orders of various kinds on shipboard. 1400 w. Elektrotech Zeitschr—July 19, 1900. No. 35805 B.

Space Telegraphy.

Prof. Braun's System of Wireless Telegraphy (Telegraphie ohne Draht nach dem System des Prof. Braun-Strassburg). The transmitter is a Leyden jar, with self-induction in its discharge circuit, which

sends out longer waves than the customary apparatus. 900 w. *Elektrizität*—July 21, 1900. No. 35819 C.

Telephone Exchange.

The New Telephone Exchange No. 1 in Berlin (*Das Neue Fernsprech-Vermittlungsamt I. in Berlin*). H. Lindow. A well illustrated description of switchboards, wiring and many other details. 3200 w. *Elektrotech Zeitschr*—July 26, 1900. No. 35810 B.

Telephone Recorder.

Recording Telephones. Describes the "Telephonograph" and the "Telegraph-one," two recent inventions of a recording telephone. Ill. 2000 w. *Nature*—Aug. 16, 1900. No. 36120 A.

The Poulsen Telephonograph (*Der Telephonograph von Poulsen*). An illustrated description of this apparatus for making a magnetic record of telephone messages on a steel wire or ribbon, which record can reproduce the message at will. 1200 w. *Elektrizität*—June 23, 1900. No. 35817 C.

The Telegraphone. From *La Nature*. Illustrated description of the instrument and its applications. 1200 w. *Sci Am Sup*—Aug. 25, 1900. No. 36048.

The Telephonograph (*Die Weltausstellung in Paris 1900. Der Telephonograph*). Hans Zopke. An illustrated description of Poulsen's "telegraphon," for recording telephonic messages magnetically on steel wire or tape, with its many applications. 1600 w. *Glaser's Annalen*—Aug. 1, 1900. No. 35878 D.

Telephones.

Interior Telephone Systems. W. S. Henry. Describes the working of intercommunicating systems. Ill. 2500 w. *Am Elect'n*—Aug., 1900. No. 35664.

Some Interesting Faults on Telephone Circuits. Illustrated explanation of the cause of various disturbances. 1200 w. *Elec Rev, Lond*—July 27, 1900. No. 35748 A.

The Dardeau Direct-Call Telephone. Describes the system, illustrating the instrument. 1600 w. *Engng*—July 27, 1900. No. 35732 A.

DISTRIBUTION.

Earthing.

On "Earthing" and Earth Connections. A discussion of this subject, suggested by Mr. Wordingham's recent paper. 1800 w. *Elec Rev, Lond*—Aug. 10, 1900. No. 35989 A.

Fuse Protection.

The Evolution of Safe and Accurate Fuse Protective Devices. Joseph Sachs. Discussion of this paper, which was published in the Feb. issue, both in New York and Chicago. 25500 w. *Trans Am Inst*

of Elec Engs—June and July, 1900. No. 35997 D.

Line Wire.

The Use of Aluminum Line Wire and Some Constants for Transmission Lines. F. A. C. Perrine and F. G. Baum. Presents the results of a careful study of this wire. Concludes that aluminum can be safely used in place of copper when proper precautions are taken. 7500 w. *Trans Am Inst of Elec Engs*—June and July, 1900. No. 35996 D.

Paris Exposition.

The Service Switchboards of the Paris Exposition, Electricity Building. Illustrates and describes the two switchboards, one used for continuous currents and the other for alternating currents. 2500 w. *Elec Wld & Engr*—Aug. 18, 1900. No. 35975.

Power Distribution.

Electrical Power Distribution. W. E. Ayrtton. Discusses the four Electric Power Distribution Bills, recently before the British Parliament, and the benefits to follow. 5000 w. *Nature*—July 26, 1900. No. 35740 A.

Scattered Areas.

The Distribution of Electricity to Scattered Areas. L. Andrews. Read at Leeds, Eng., before the Munic. Elec. Assn. Deals with alternating vs. continuous currents for thinly populated sections. 2500 w. *Elect'n, Lond*—Aug. 10, 1900. No. 36000 A.

Switching.

The Evolution of Switch Gears for High-Pressure Alternating Currents. W. E. Warrilow. Part first is introductory to descriptions of apparatus used for dealing with currents at 2,000 volts pressure. 1300 w. *Elec Engr, Lond*—Aug. 10, 1900. Serial. 1st part. No. 36015 A.

Temperature.

On the Heating of Underground Cables (*Ueber die Erwärmung Unterirdisch Verlegter Kabel*). Dr. Richard Apt. Theoretical discussion, and results of experiments with alternating currents, with diagrams, tables and curves. 2800 w. *Elektrotech Zeitschr*—July 26, 1900. No. 35807 B.

ELECTRO-CHEMISTRY.

Electro-Galvanizing.

Some Notes on Electro-Galvanizing. Sherard Cowper-Coles. Illustrates and describes the process and recent improvements. 1400 w. *Prac Engr*—Aug. 10, 1900. No. 36021 A.

Electro-Metallurgy.

Electro-Metallurgy in 1899 (*L'Electro-metallurgie en 1899*). P. Chalon. A general review of progress during the year.

3200 w. Rev Universelle d Mines—March, 1900. No. 35866 F.

Electro-Photography.

Curious Electro-Photographic Experiments. Illustrates and describes experiments made by Francis E. Nipher, as reported in a paper contributed to the Trans. of the Acad. of Science of St. Louis. 1500 w. Elec Rev, Lond—Aug. 10, 1900. No. 35988 A.

Paris Exposition.

Electro-Chemistry at the Paris Exposition (Die Weltausstellung in Paris 1900. Elektrochemie). Dr. Chr. Heinzerling. A general review of the electro-chemical exhibit at Paris, including also electric furnaces and accumulators. 3600 w. Zeitschr de Ver Deutscher Ing—Aug. 4, 1900. No. 35873 D.

Soda and Chlorine.

The Electrolytic Production of Soda and Chlorine. James F. Hobart. Describes the process of separating the soda and chlorine. Ill. 1600 w. Am Elect n—Aug., 1900. No. 35665.

ELECTRO-PHYSICS.

Interrupters.

Electrolytic Interrupters. Benj. F. Bailey. A study of direct current curves, giving interesting photographs of discharges, etc. 3300 w. Elec Wld & Engr—Aug. 11, 1900. No. 35934.

Resistance.

Resistance Diagrams of Sections (Widerstandsbild von Querschnitten). Karl Oertling. Graphical and analytical methods for calculating the resistance of different cross-sections. 3500 w. 1 plate. Oest Monatschr f d Oeff Baudienst—Aug., 1900. No. 36153 G.

Thermo-Electricity.

Thermo-Electric Currents (Ueber Thermoelektrische Ströme). H. Egg-Sieberg. An illustrated account of experiments tending to confirm the hypothesis that the direction and intensity of thermo-electromotive forces depend upon the rate of fall of temperature in the conductors. 2000 w. Elektrotech Zeitschr—July 26, 1900. No. 35809 B.

GENERATING STATIONS.

Accumulator Switch.

Sectional Switch for Charging Accumulators (Sektionsschalter für Akkumulator-enladung). Arthur Löwit. A description of a switch with several contacts which facilitates the charging and discharging of batteries in various groupings; with diagram. 500 w. Elektrotech Zeitschr—Aug. 2, 1900. No. 35813 B.

Alternators.

Design of Alternators. H. F. Parshall and H. M. Hobart. Describes a method

founded upon experimental data. Part first discusses inherent regulation, and excitation regulation. 1800 w. Engng—July 27, 1900. Serial. 1st part. No. 35731 A.

Polyphase Alternate-Current Machinery. Explains the action and construction. 3000 w. Col Guard—Aug. 10, 1900. Serial. 1st part. No. 36012 A.

Dynamo.

A Dynamo for the Direct Generation of a Uni-Directional Current (Dynamomaschine zur Direkten Erzeugung, eines Gleichgerichteten Stromes). An illustrated description of a dynamo in which part of the armature winding is surrounded by a strangely paramagnetic substance, and part by a diamagnetic or non-magnetic substance. 600 w. Elektrizität—July 7, 1900. No. 35818 C.

The 3,000-Watt Augsburg-Nuremberg Engine and Helios Dynamo at the Paris Exposition (Exposition de 1900. Groupe Electrogène de 3,000 Kilowatts des Sociétés d'Augsbourg-Nuremberg et Helios). Alfred Boudon. An illustrated description of this group, consisting of a 4-cylinder horizontal engine directly connected to a dynamo which generates both simple-alternating and triphase currents. 3000 w. 1 plate. Génie Civil—July 28, 1900. No. 35882 D.

Electric Plants.

Some Figures on the Cost of Electric Power Plants. Philip Dawson. Examines the cost of the individual plant, and the relations between the power to be installed and the cost. 2400 w. Engng—July 27, 1900. No. 35734 A.

Gas-Electric Plants.

The Use of Gas Engines in Connection with Electric Power Plants. Philip Dawson. The first of a series of articles discussing the conditions which will, by the adoption of gas engines, enable a great economy to be effected in the production of electrical energy. 4200 w. Engng—Aug. 10, 1900. Serial. 1st part. No. 36002 A.

Paris Exposition.

Heavy Electrical Engineering at the Paris Exposition (Die Weltausstellung in Paris 1900. Die Starkstromtechnik). Prof. M. Fries. A general review of the generation of electrical currents at the Exposition, and their distribution for power and lighting. Serial. 1st part. 3600 w. Zeitschr d Ver Deutscher Ing—July 14, 1900. No. 35868 D.

The Central Station and Power Plant on the Champ de Mars (Pariser Weltausstellung 1900. Die Kraftcentralen auf dem Marsfeld). A. Weber. An illustrated description of the great generating plants at the Exposition, with tables of the engines and dynamos. Serial. 2 parts.

3000 w. Schweiz Bauzeitung—July 21, Aug. 4, 1900. No. 36155 each B.

Storage Batteries.

Some Results Obtained With a Storage Battery of Twenty Thousand Cells. John Trowbridge. Read at meeting of Am. Acad. of Arts and Sciences. An illustrated account of interesting experiments. 2400 w. Nature—Aug. 2, 1900. No. 35792 A.

Switchboards.

Modern Switchboard Practice. Frank C. Perkins. Part first discusses polyphase high-tension switchboards. Ill. 2500 w. W Elect'n—Aug. 18, 1900. Serial. 1st part. No. 35994.

Triphase.

The Triphase Electric Company's Plant at Asnieres. From *Le Génie Civil*. Illustrated description of a 20,000 K. W. plant arranged in an unusual manner to secure short steam piping and completely independent units. 2500 w. Eng Rec—Aug. 11, 1900. No. 35753.

HEATING AND WELDING.

Electric Heat.

The Possibilities of Electric Heat as Limited by the Cost of Production. Alton D. Adams. Does not consider electric heat desirable from the economical point of view. 1200 w. Eng News—Aug. 23, 1900. No. 36064.

LIGHTING.

Bordeaux.

The Electric Lighting of the Harbor of Bordeaux, France (L'Eclairage Electrique du Port de Bordeaux). Paul Meunier. An account of the arc-light system along the water front. 4000 w. 1 plate. Ann d Ponts et Chaussées—1st quarter, 1900. No. 35858 E + F.

Flickering.

Light Fluctuations and their Cure (Lichtschwankungen und ihre Beseitigungen). K. Schindler. A discussion of the causes of flickering and irregularity in electric lights, and means for remedying the trouble. 1500 w. Elektrotech Rundschau—June 15, 1900. No. 35820 B.

Gloucester.

Gloucester Electricity Works. Historical and descriptive account, with illustrations. 3300 w. Elec Rev, Lond—Aug. 3, 1900. No. 35791 A.

Nernst Lamp.

Nernst Lamp at the Exposition. Illustrated description of this interesting exhibit and its operation. 1300 w. Sci Am—Sept. 1, 1900. No. 36179.

Pan-American Exposition.

The Electrical Tower at the Pan-American Exposition. Edward Hale Brush.

Illustration, with description of this feature of the exposition. 1500 w. Sci Am Sup—Aug. 4, 1900. No. 35650.

Street Lighting.

Street Lighting by Series Alternating-Current Arc Lamps. Arthur L. Rice. Describes two methods that might be used and give good results. 1800 w. Am Elect'n—Aug., 1900. No. 35660.

MEASUREMENT.

Chronograph.

The Application of Recording Apparatus in Electrical Measurements (Anwendung des Registrirapparates bei Elektrischen Messungen). W. Marek. An illustrated description of the use of the chronograph in electrical experiments, with tables of observations. 2000 w. Elektrotech Zeitschr—Aug. 2, 1900. No. 35814 B.

Hysteresis.

On Rowland's New Method for Measuring Electric Absorption, and Losses of Energy Due to Hysteresis and Foucault Currents, and on the Detection of Short Circuits in Coils. Louis M. Potts. Describes investigations made with the object of testing these methods. 6300 w. Am Jour of Sci—Aug., 1900. No. 35647 D.

Meters.

Rate Meters. Howard Hendrickson. Read before the Pacific Coast Trans. Assn. Discusses the requirements of a perfect rate meter, and describes a mechanical device which is said to be accurate and not liable to get out of order. Ill. 3200 w. Jour of Elec—July, 1900. No. 35767.

Photometry.

Determination of the Average Spherical Intensity of a Light by a Single Reading (Die Bestimmung der Mittleren Räumlichen Lichtintensität durch nur eine Messung). R. Ulbricht. Illustrated description of apparatus and experiments. The source of light is placed inside a hollow sphere with reflecting interior surface, with a window through which the illumination is observed. 1800 w. Elektrotech Zeitschr—July 19, 1900. No. 35803 B.

The Photometry of the Arc. Abstract of a progress report by Prof. C. P. Matthews, of Purdue University, on a series of investigations being made, and presented at the annual meeting of the Nat. Elec. Lgt. Assn. Ill. 1800 w. Eng News—Aug. 9, 1900. No. 35943.

Standards.

Standards of E. M. F. John Henderson. States the conditions to be fulfilled by any satisfactory standard, and examines the behavior of various cells. Ill. 3500 w. Elec Eng, Lond—July 27, 1900. Serial. 1st part. No. 35750 A.

Testing.

The Work of the Physical-Technical German Imperial Laboratory from February, 1899, to February, 1900 (Thätigkeit der Physikalisch-Technischen Reichsanstalt in der Zeit vom Februar, 1899, bis Februar, 1900). A record of the electrical and magnetic work of the institution, abstrated from the Zeitschr. f. Instrk. Serial. 2 parts. 3500 w. Elektrotech Zeitschr.—July 19, 26, 1900. No. 35811 each B.

Traction Meter.

A Meter for Measuring Tractive Force on Electric Tramcars. Gisbert Kapp. Translation of paper read before the Verband Deutsches Electrotechniker. Describes the apparatus, giving diagram and illustration. The height of the liquid indicates the tractive force. 2000 w. Elect'n, Lond—Aug. 17, 1900. No. 36127 A.

POWER APPLICATIONS.**Cranes.**

The Operating of Continuous Current Electric Cranes (Ueber die Steuerung Elektrischer Gleichstromkrahne). Max Vogelgesang. An illustrated article describing controllers for electric cranes, with the theory of crane operation. 4000 w. Elektrotech Zeitschr—Aug. 2, 1900. No. 35812 B.

Cripple Creek.

Electric Power in Cripple Creek District. J. W. Dickerson. Illustrated detailed description of the power equipment. 1500 w. Mod Mach—Aug., 1900. No. 35658.

Electric Vehicles.

See Mechanical Engineering, Automobilmism.

Induction Motors.

Alternating-Current Induction Motors. A. C. Eborall. Considers points connected with the construction, design and performance of modern single and poly-phase induction motors, and recent developments. Ill. 3500 w. Elect'n, Lond—Aug. 17, 1900. Serial. 1st part. No. 36128 A.

Paris Exposition.

Two Electrically Driven Pumps at the Paris Exposition. Illustrated descriptions of the Riedler pump, and the Ehrhard and Sehmer pump. 1100 w. Elec Wld & Engr—Aug. 25, 1900. No. 36080.

Proving Ground.

The Electrical Equipment at the Indian Head Naval Proving Grounds. Illustrates and describes probably one of the most flexible equipments ever designed. 2800 w. Elec Wld & Engr—Aug. 25, 1900. No. 36078.

Pumping.

Some Data on Pumping by Electricity.

Lewis A. Hicks. On the success of the centrifugal pump, and the cost of the plants and their operation. 1800 w. Jour of Elec—July, 1900. No. 35768.

Steel Works.

Electric Power in the Parkgate Steel Works, England. Illustrates and describes a recent installation in works of large capacity. 2300 w. Elec Wld & Engr—Aug. 4, 1900. No. 35703.

The Marchéville-Daguin Salt Works and Soda Works (Saline et Soudière de la Société Marchéville-Daguin et Cie). Ch. Dantin. An illustrated description of these works and their method of operation, in which an electric plant plays an important part. 5000 w. Génie Civil—July 28, 1900. No. 35883 D.

Tools.

Some Notes on the Electrolytic Drilling and Slotting of Metals. Sherard Cowper-Coles. Brief report of experiments, with illustrations. 300 w. Elec Rev, Lond—July 27, 1900. No. 35749 A.

TRANSMISSION.**Long Distance.**

Limits of Electric Transmission. Alton D. Adams. Discusses long distance transmission from the coal mines to great cities, showing that it is not economical and not to be considered even if the fuel is free. 2000 w. Sci Am—Aug. 25, 1900. No. 36045.

I. Regulation in Long-Distance Transmissions. Frederic A. C. Perrine. II. Transmission System Regulation. C. L. Cory. Papers and discussion before the Pacific Coast Trans. Assn. Ill. 9700 w. Jour of Elec—July, 1900. No. 35765.

Storage Batteries.

Application of Storage Batteries to Transmission Systems. C. O. Poole. Read before the Pacific Coast Trans. Assn. Presents the advantages of storage batteries in central stations, and discusses their cost, maintenance, etc. Also general discussion. 4000 w. Jour of Elec—July, 1900. No. 35766.

MISCELLANY.**Dielectrics.**

Dielectric Strength. Jas. Rowland Bibbins. A brief exposition of results of various experiments, especial attention being given toward the establishment of a secondary standard for use in ordinary shop tests of materials and apparatus. 3500 w. Elec Wld & Engr—Aug. 25, 1900. No. 36079.

Electric Shock.

Electric Shock. Describes the effect of the electric current on the human body, and illustrates the operation of resuscitation. 4500 w. Col Guard—Aug. 3, 1900. No. 35901 A.

Electrical Industry.

The Electrical Industry in America and Great Britain. J. R. Bainton. Extract from a paper before the Elec. Assn. of New South Wales. Contrasts the methods of these two countries. 2000 w. Aust Min Stand—July 5, 1900. Serial. 1st part. No. 35961 B.

Electricity.

Some Notes on Dr. R. C. Shettle's View of the Ultimate Nature of Electricity. Spencer L. Fletcher. States the view taken, and discusses the opinions of men of science. 2000 w. Elec Engr, Lond—Aug. 17, 1900. No. 36126 A.

Far East.

Electrical Possibilities in the Far East. Philip Jaisohn. This first article discusses electrical trade, electrical engineering and investments in Japan. 2200 w. Elec Wld & Engr—Aug. 4, 1900. Serial. 1st part. No. 35704.

German Society.

Minutes of the Annual Meeting of the

Verband Deutscher Elektrotechniker at Kiel, June, 1900 (Verband Deutscher Elektrotechniker. Bericht über die 8. Jahresversammlung in Kiel, 17 bis 20 Juni, 1900). Full minutes, with reports of various committees. 23000 w. Elektrotech Zeitschr.—Aug. 2, 1900. No. 35815 B.

Phonogram Archives.

The Phonogram Archives of the Vienna Academy of Sciences (Das Phonogramm-Archiv der Academie der Wissenschaften in Wien). An account of a plan for forming a large, scientific collection of phonograph records, and discussion of methods for their permanent preservation. 1600 w. Electro-Techniker—July 15, 1900. No. 35822 B.

Tesla's Inventions.

Some Novel Inventions of Nikola Tesla. J. Wright. Illustrates and describes an electrolytic meter, and other devices. 2000 w. Elec Engr, Lond—Aug. 10, 1900. No. 36016 A.

GAS ENGINEERING

Acetylene.

Acetylene Laboratory Burner. Arthur Lachman. From *Am. Chem. Jour.* Discusses the acetylene Bunsen burner, the properties of the acetylene blue flame, and the comparative operating expenses of acetylene gas and gasoline gas. 2000 w. Pro Age—Aug. 15, 1900. No. 35940.

The Technology of Acetylene. Review of a book by Vivian B. Lewes. 3800 w. Jour Gas Lgt—Aug. 21, 1900. No. 36140 A.

Acetylene Black.

Acetylene Black and its Derivatives (Le Noir d'Acétylène et ses Dérivés). E. Hubou. A description of a process of obtaining amorphous carbon by decomposing acetylene, with an account of the advantages of this acetylene black, and the utilization of the bye-products. 8000 w. Mem d l Soc d Ing Civils de France—No. 12, 1900. No. 35847 G.

Carburation.

Apparatus for Producing a Gas for Welsbach Lights (Appareil à Produire le Gaz Aéro-gène). MM. de Perrodil and de Morsier. A paper treating of the advantages of a gas rich in hydrocarbons for Welsbach lights, with description of the van Vriesland carburator-compressor; and the resulting discussion. 6000 w. Mem d l Soc d Ing Civils de France—No. 7, 1900. No. 35839 G.

Composition.

The Synthesis of Commercial Gases. L. P. Lowe. Read before the Pacific Coast Gas Assn. Aims to give a simple

description of the composition of commercial gases. 4000 w. Am Gas Lgt Jour—Aug. 27, 1900. No. 36101.

Fire-Clay.

A Chapter on the Manufacture of Fire-Clay Material for Gas Works. Frederic Egner. Information concerning this product, which, it is hoped, will be of practical use to gas engineers. 2200 w. Am Gas Lgt Jour—Aug. 20, 1900. No. 35991.

Gas-Lamp.

The Scott-Snell Self-Intensifying Gas-Lamp. Illustrates and describes a novel invention, giving particulars regarding its operation. 2700 w. Jour Gas Lgt—Aug. 14, 1900. No. 36039 A.

Meters.

Automatic Meters; With a Comparison of the Price Charged for Gas Consumed by Slot and Ordinary Consumers. Paper read before the N. Brit. Assn. of Gas Mgrs., with discussion. 3500 w. Gas Wld—Aug. 4, 1900. No. 35797 A.

Petroleum.

Some Chemical and Physical Characteristics of California Petroleum. A. S. Cooper. Read before the Pacific Coast Gas Assn. Also brief discussion. 5000 w. Am Gas Lgt Jour—Aug. 20, 1900. No. 35990.

Power Gas.

The Production of Power from Blast Furnace Gases. Andrew Stewart. Discusses the progress made in utilizing these gases and the effect on the iron industry. 1400 w. Elec, Lond—Aug. 17, 1900. Serial. 1st part. No. 36119 A.

Processes.

Principles Involved in the Production of Gas by Different Processes, and Their Relative Values. W. Young. Read before the N. British Assn. of Gas Mgrs. Discusses in detail the use of coke, destructive distillation, how gas should be tested, and the best gas to supply, etc. 13800 w. Jour Gas Lgt—July 31, 1900. No. 35787 A.

The Investigation of Gas Processes. A. C. Humphreys. Read before the Pacific Coast Gas Assn. Review of experiences of one who has been investigating claims of gas processes for 25 years. Denounces the Hall process, which was recently tested. General discussion. 7500 w. Am Gas Lgt Jour—Aug. 13, 1900. No. 35783.

Retorts.

The Construction and Working of Inclined Retorts. W. R. Herring. Read before the N. Brit. Assn. of Gas Mgrs. Considers the method of constructing and working an inclined retort bench and the underlying principles. Ill. Also discussion. 7500 w. Gas Wld—Aug. 4, 1900. No. 35796 A.

Small Works.

Impressions of Small Gas-Works in Ireland. Percy Griffith. Read before the N. of Ireland Assn. of Gas Mgrs. Considers the ownership, capital, accounts, condition of works and mains, price, residual products, etc. 3500 w. Jour Gas Lgt—Aug. 21, 1900. No. 36141 A.

Smelting.

Blast Furnace Smelting by Water Gas. C. C. Longridge. Considers the use of water gas for lead ore smelting, thus illustrating its adaptability for blast furnace use. 2000 w. Engr, Lond—Aug. 17, 1900. No. 36108 A.

Temperatures.

Observations on Retorting and Condensing Temperatures. Forbes Waddell. Read before the North British Assn. of Gas Mgrs. An account of experiments made by the writer with the view of saving of heat and returning it to the setting, and of cooling the products more gradually. Gives results and discussion. 4000 w. Jour Gas Lgt—Aug. 14, 1900. No. 36040 A.

MARINE AND NAVAL ENGINEERING

Battleships.

The Battleship of the Future. F. C. Goodall and A. C. Holzapfel. Read before the Congress of Naval Archts., in Paris. Outlines the type of vessel which recent improvements in armor plate and guns has made possible, advocating increase in size. 2000 w. Naut Gaz—Aug. 9, 1900. No. 35780.

Boilers.

Navy Boilers. Editorial continuing the discussion of the Admiralty Memorandum as to the form of boiler for British warships. 3500 w. Engng—July 27, 1900. No. 35735 A.

Crane Regulations.

Crane Regulations at Newcastle, N. S. W. Regulations for the working of cranes and wharf at this port. 2600 w. U. S. Cons Repts, No. 810—Aug. 17, 1900. No. 35968.

Cruisers.

Highborn's Protest. From a letter to the Secretary of the Navy on the subject of protected cruisers. 1800 w. Marine Rev—Aug. 23, 1900. No. 36073.

Fire.

Ships and Docks of the North German Lloyd Steamship Co. Destroyed by Fire. An illustrated account of the destructive fire of June 30, 1900. 700 w. Marine Engng—Aug., 1900. No. 35747 C.

Fouling.

The Fouling of Ships. W. H. Atherton.

On the nature, effect, and prevention of fouling. Also an appendix and discussion. 8000 w. Trans of N. E. Coast Inst of Engs & Shipbuilders—June, 1900. No. 35987 F.

Freighters.

Steel Freighters "Pleiades" and "Hyades," for the Boston Towboat Co. Illustrated detailed description of vessels designed to carry freight in bulk; such as coal, grain, etc. 1800 w. Marine Engng—Aug., 1900. No. 35745 C.

Fuel.

Petroleum Fuel for Warships. Alton D. Adams. Presents the great advantages to be derived from petroleum fuel, but considers the present production inadequate and the price prohibitive. 1800 w. Sci Am—Aug. 11, 1900. No. 36928.

Germany.

Shipbuilding in Germany (Les Construction Navales en Allemagne). Raoul Dubreuil. An article giving the German naval program, and showing the wonderful development of shipbuilding in Germany in recent years, with tables of statistics. 2000 w. Revue Technique—July 10, 1900. No. 35835 D.

Grosser Kurfürst.

The North German Lloyd Steamer "Grosser Kurfürst" (Der Norddeutsche Lloyd dampfer "Grosser Kurfürst"). An illustrated description of this large ocean liner. 800 w. Schiffbau—July 8, 1900. No. 35824 D.

Shipbuilding in Germany. George Crouse Cook. Illustrated description of Kaiserliche Werft, a German navy yard credited with the construction of many modern vessels of war. 1800 w. Marine Rev—Aug. 23, 1900. No. 36072.

Lake Steamer.

Fine New Great Lakes Passenger Steamer. Illustration with description of the "Chippewa," built for the Arnold Transit Co. 2000 w. Naut Gaz—Aug. 2, 1900. No. 35710.

Lighthouses.

See Civil Engineering, Construction.

Lightship.

Lightship No. 72 for the Diamond Shoals. Relates the difficulties experienced in protecting vessels from this point of danger, and gives illustration and brief description of the new vessel. 900 w. Marine Rev—Aug. 9, 1900. No. 35781.

Naval Machinery.

Machinery for the United States Navy Armored Cruisers. G. W. Melville. A brief comparison of the merits and demerits of the preliminary designs. Also editorial. 3400 w. Engr, Lond—Aug. 3, 1900. No. 35908 A.

Navigation.

The Navigation Interests of Nations in Ports and Waterways, and Modern Means for Their Improvement. Lindon W. Bates. Read at the International Congress on Navigation, at Paris. Considers improvement of waterways and terminal facilities. 5500 w. Naut Gaz—Aug. 23, 1900. No. 36053.

Schools.

Schools of Marine Engineering and Naval Architecture. George Crouse Cook. An illustrated account of the courses and conditions at Glasgow University, written by an American student. 2500 w. Marine Engng—Aug., 1900. No. 35746 C.

Shipping.

Japanese Shipping. An interesting review of recent developments. 2000 w. Engr, Lond—Aug. 3, 1900. No. 35910 A.

Ship Telegraph.

See Electrical Engineering, Communication.

Shipyards.

Recent Extensions at Fairfield Shipyard. Notes on recent improvements and new features. 2400 w. Engr, Lond—Aug. 17, 1900. No. 36110 A.

Steamer.

New Channel Steamer. The "Alberta." Illustrated description of a fast English passenger boat, built for night service. 1800 w. Naut Gaz—Aug. 16, 1900. No. 35980.

The Newhaven and Dieppe Channel Steamer "Arundel." Illustrations with description of vessel and equipment. 1100 w. Engng—Aug. 17, 1900. Serial. 1st part. No. 36104 A.

Submarine.

Submarine Navigation (La Navigation Sous-Marine). H. Noalhat. This part contains a review and discussion of various methods of directing the course of a submarine vessel. Serial. 1st part. 4500 w. Revue Technique—May 10, 1900. No. 35827 D.

Troopship.

The Indian Troopship "Hardinge." Illustrated description of a twin-screw vessel with a gross tonnage of about 5,600 tons, and a capacity for 1,400 troops and all accoutrements. 1700 w. Engr, Lond—Aug. 17, 1900. No. 36111 A.

Tugboats.

New Type Tugboat. Illustration and description of the "Delmar," combination harbor and sea-towing steamer. 1000 w. Naut Gaz—Aug. 9, 1900. No. 35779.

Wrecks.

Notes on Wreck Raising. David W. Noakes. Read before the Paris Congress of Naval Architecture. An account of operations conducted in the river Thames. 6500 w. Engng—Aug. 17, 1900. No. 36106 A.

Yachts.

On Yacht Measurements, Together with Some Remarks on the Action of Sails. H. C. Vogt. Read before the Inst. of Naval Archts. Discusses these subjects and the importance of framing a yacht-tonnage rule which is correct and easily understood. Considers the weight necessary to form such a measurement rule. 3500 w. Engs' Gaz—Aug. 1, 1900. No. 35789 A.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Bearings.

Roller Bearings and Some Connected Matters. A discussion of the most suitable bearings for a motor vehicle, with abstract of patent specifications recently issued to Edw. P. Cowles. 2700 w. Horseless Age—Aug. 15, 1900. No. 35918.

Competitions.

Motor-Vehicle Competitions in France. Report of the competitions of 1898, of heavy weights, and of 1899, of motor-cars

plying as street cabs. 1200 w. Horseless Age—Aug. 22, 1900. No. 36038.

Cooling.

The Cooling of Explosion Motors. Extracts from the report of MM. Grouvelle and Arquembourg, at the International Congress. Discusses the two systems commonly employed. Ill. 2200 w. Horseless Age—Aug. 22, 1900. Serial. 1st part. No. 36037.

Electric Vehicles.

Electric Automobiles. William Baxter, Jr. Considers the limits in the present state of electrical development, and gives illustrated descriptions of various vehicles. 3000 w. Pop Sci M—Sept., 1900. No. 36130 C.

Fire-Tube Boilers.

Is the Fire-Tube Carriage Boiler Dangerous? Editorial discussion of recent criticisms of this type. 1400 w. Horseless Age—Aug. 22, 1900. No. 36036.

Heavy Vehicles.

Heavy Motor Vehicles for Road Service. F. M. Maynard. Mr. Maynard's second paper gives interesting details of design, construction and performance of leading British types of vehicles, with many illustrations of successful machines. 3000 w. Engineering Magazine—Sept., 1900. No. 36172 B.

Ignition.

A Storage Battery Spark Ignition. Hugh Dolnar. An illustrated detailed description of a spark outfit for mechanically propelled vehicles. 2000 w. Am Mach—Aug. 9, 1900. No. 35938.

Improvements.

The Future of the Automobile—Suggested Improvements. A discussion of the use of excessive powers, means of rendering the motor more elastic, etc. 2700 w. Sci Am Sup—Aug. 25, 1900. No. 36049.

Motor Car.

Capel's Motor Car. Illustrates and describes a vehicle containing many features of novelty. 1300 w. Auto Jour—Aug., 1900. No. 36121 A.

Motor Vehicles.

Automobiles. T. J. Martin. Considers the motive powers in practical use at present, with their comparative costs of operation. Also discussion. 2400 w. Jour Assn of Engng Socs—July, 1900. No. 35982 C.

Automobile Vehicles. Louis Derr. A discussion of the various methods by which vehicles of the present moment are propelled. 5300 w. Jour Assn. of Engng Socs—July, 1900. No. 35981 C.

Front-Driven Motor Carriages. Illustrates and describes various vehicles utiliz-

ing this idea. 2800 w. Auto Jour—Aug., 1900. No. 36122 A.

The Capel Motor Carriage. Illustrated description of a carriage propelled by an internal combustion engine using petroleum spirit. 700 w. Engr, Lond—Aug. 3, 1900. No. 35914 A.

HYDRAULICS.

Centrifugal Pumps.

The Schabaver Centrifugal Pumps (Rapports de M. Léon Masson, sur les Pompes Centrifuges Schabaver). Report on a special type of centrifugal pumps, for elevating liquids to great heights, with illustrations, and curves and tables of tests. 2000 w. Bull d l Soc d'Encouragement—June 30, 1900. No. 35865 G.

Hydraulic Equipment.

Hydraulic Engineering in the Metropolitan Power House. Illustrated detailed description of the water supply, fittings, plumbing and fire protection. 1800 w. Ir Age—Aug. 23, 1900. No. 36034.

Hydraulic Governing.

Commercial Requirements of Water-Power Governing. Elmer F. Cassel. A critical examination of the principles involved in the governing of water-wheels, and an exposition of an improved method. 2500 w. Engineering Magazine—September, 1900. No. 36171 B.

Hydraulic Jack.

Theory of the Hydraulic Jack. George F. Hodgins. Explanatory. 1500 w. R R Car Jour—Aug., 1900. No. 35920.

Power Improvements.

A New Rack and Other Improvements to the Feeder for the Middlesex Company, Lowell, Mass. Arthur T. Safford. Illustrates and describes work that gave increase of power, and simplified the conditions for controlling the water power. 4300 w. Jour Assn of Engng Socs—July, 1900. No. 35983 C.

Pump.

The Mammoth Pump. From *Ingeniøren*, Copenhagen. Abstract. Describes a method of raising water without any bucket or pump work, explaining the principle and gives several applications. 2300 w. Col Guard—Aug. 3, 1900. No. 35902 A.

Pumping.

See Electrical Engineering, Power Applications.

Pump Tests.

Tests of Centrifugal Pumps Under High Heads. Slightly condensed from a paper read before the Pacific Coast Elec. Trans. Assn. Describes the experimental tests of the pumps of the Kern County Land Co., explaining methods of testing and giving results. 4800 w. Eng News—Aug. 9, 1900. No. 35947.

Syphons.

Syphon Mains (Heberleitungen). Heinrich Adolf. An illustrated description of syphon plants for connecting artesian wells and raising water from rivers. 2300 w. Zeitschr d Oest Ing u Arch Ver—July 20, 1900. No. 35893 B.

Water Power.

The Clergue Enterprises at Sault Ste. Marie. An account of the industries developed to utilize the power of Lake Superior. 4500 w. Ir Age—Aug. 9, 1900. No. 35924.

See Civil Engineering, Hydraulics.

MACHINE WORKS AND FOUNDRIES.**Cranes.**

A Twenty-five Ton Hydraulic Traveling Crane. Illustrates and describes a traveling crane recently installed in the Altoona shops of the Pennsylvania Railroad. 700 w. Am Mach—Aug. 9, 1900. No. 35939.

See Electrical Engineering, Power Applications.

Cupolas.

Charging a Cupola. Edward Kirk. Describes how to make a fire in a cupola, and other matters relating to its proper management. 2400 w. Foundry—Aug., 1900. No. 35673.

Cupola Practice. Edward B. Gilmour. Describes the cupola furnace and states its advantages, and considers the investigations of Mr. Hart as to causes affecting its working. 1100 w. Foundry—Aug., 1900. No. 35675.

The Cupola Practice in Bessemer Steel Works. S. M. Rodgers. Considers the circumstances and conditions governing the proper manipulation of the cupola. 1800 w. Foundry—Aug., 1900. No. 35678.

Dies.

Some Special Forming Dies. Joseph V. Woodworth. Illustrates and describes dies for forming cold-rolled sheet steel, .048 inch thick, to shape shown. 900 w. Am Mach—Aug. 16, 1900. No. 35959.

Factory.

See Architectural Engineering, Construction.

Flanges.

Turning Flanges on a Locomotive Boiler. H. D. Van Doorn. An illustrated description of the methods employed. 700 w. Am Mach—Aug. 23, 1900. No. 36041.

Gating.

Gating. Paul R. Romp. Discusses the manner in which a mold is gated. Ill. 800 w. Foundry—Aug., 1900. No. 35676.

Jigs.

Bending Jigs. Joseph V. Woodworth.

Illustrates and describes bending in sheet metal that it would be impracticable to do in the press. 600 w. Am Mach—Aug. 23, 1900. No. 36044.

Lathe.

A Staff Lathe. A. H. Cleaves. Illustrated description of a machine used extensively in watch and clock work. 1000 w. Am Mach—Aug. 23, 1900. No. 36042.

Locomotive Works.

Some of the Interesting Features of the Schenectady Locomotive Works. Illustrations with description. 2500 w. Mach. N. Y.—Aug., 1900. No. 35640.

Punching.

Making Gears and Racks by Punching. Joseph V. Woodworth. Illustrated description. 800 w. Am Mach—Aug. 23, 1900. No. 36043.

Reorganization.

The Task of Reorganization. Considers the problem briefly, discussing the design, men, and methods. 3300 w. Engng—July 27, 1900. No. 35736 A.

Riveter.

A Large Hydraulic Riveter. Illustrated description of a machine designed by Ernest W. Naylor, for use in the Altoona shops. 800 w. Am Mach—Aug. 16, 1900. No. 35957.

Shrinkage.

Absolute Shrinkage. William Roxburgh. Discusses irregular shrinkage, considering design, equality of metal, slackening, comber, etc. 2300 w. Foundry—Aug., 1900. No. 35677.

Tools.

See Electrical Engineering, Power Applications.

Tool Steel.

The Taylor-White Process of Treating Steel. An illustrated account of a series of tests made to exhibit the quality of steel treated by this process. 1700 w. Am Mach—Aug. 16, 1900. No. 35956.

The Taylor-White Steel Process. A description of the results of a process for hardening tools, employed in the machine shops of the Bethlehem Steel Co. 1100 w. Eng Rec—Aug. 4, 1900. No. 35714.

Works Management.

Commercial Organization of the Machine Shop. Hugo Diemer. Prof. Diemer's fourth paper deals with the operation of the production department and with the actual execution of the work in the shop. 3000 w. Engineering Magazine—Sept., 1900. No. 36167 B.

MATERIALS OF CONSTRUCTION.**Corrosion.**

See Mining and Metallurgy, Iron and Steel.

Elasticity.

The Error in Hooke's Law (Der Fehler in Hooke's Gesetz). Francis Rust. A simple experiment and a mathematical demonstration, showing that Hooke's law of elasticity is inadequate in the case of a beam fixed at one end and bent by its own weight. 3000 w. Oest Monatschr f d Oeff Baudienst—July, 1900. No. 36-151 G.

Expanded Metal.

Expanded Metal (Le Métal Déployé). An illustrated account of the manufacture and numerous applications of J. F. Golding's metal lattice-work invention. Serial. 1st part. 3200 w. Revue Technique—July 10, 1900. No. 35834 D.

Specifications.

International Standard Specifications for Steel and Iron. A discussion of the report of the American section of the International Assn. for Testing Materials. 6700 w. Col Guard—July 27, 1900. No. 35711 A.

POWER AND TRANSMISSION.**Air Compressors.**

Explosions and Ignitions in Air-Compressors and Receivers. Alfred George White. From Pro. of Inst. of Civ. Engs. An account of an occurrence of this nature, with description of compressor, and discussion of cause. 1800 w. Am Mach—Aug. 2, 1900. No. 35669.

Belting.

A Study of Leather Belting (Etude sur les Courroies de Transmission). Robert Moulin. A discussion of leather belts, particularly of their strength and adhesion. 1800 w. Revue Technique—June 10, 1900. No. 35831 D.

Moving Stairways.

Moving Stairways at the Paris Exposition (Les Chenims Elévateurs à l'Exposition de 1900). J. Laverchère. A well illustrated description of several kinds of electrically driven, continuously moving inclined planes in operation at the Paris Exposition. 1500 w. Génie Civil—July 14, 1900. No. 35880 D.

Shafts.

Graphical Aids to the Design of Shafts Subject to Bending and Twisting. Robert A. Bruce. Diagram with explanation of its construction and use. 4000 w. Prac Engr—Aug. 17, 1900. No. 36123 A.

SPECIAL MOTORS.**Gas-Electric Plants.**

See Electrical Engineering, Generating Stations.

Gas Engines.

Blast Furnace Gas Engine. Report of tests, conducted under direction of Prof.

H. Hubert, of Liege Univ., with the Delamare-Deboutteville and Cockerill 600 h.-p. gas engine, consuming blast-furnace gas. 2200 w. Mod Mach—Aug., 1900. No. 35657.

Safety in Gas Engine Installation. J. D. Lyon. Discusses points in the installation of gas engines to secure safety. 1600 w. Ir Trd Rev—Aug. 2, 1900. No. 35668.

Some Notes on Larger Types of Gas Engines. J. B. Crockett. Read before the Pacific Coast Gas Assn. Gives a brief history of the best known engines previous to 1892, and describes the latest improvements. Ill. General discussion. 6500 w. Am Gas Lgt Jour—Aug. 6, 1900. No. 35768.

Test of a Blowing Engine Using Blast-Furnace Gas (Essai d'une Machine Soufflante à Gaz de Haut Fourneau). Abstract of a report of H. Huber, chief engineer, of a test of a 600 horse-power Cockerill gas engine using blast-furnace gases, at Seraing; with tables. 6000 w. Revue Technique—July 10, 1900. No. 35836 D.

Test of a 600-Horse-Power Blast Furnace-Gas Engine (Versuche an der 600 Pferdigen Gichtgasmaschine mit Gebläse, System Delamare Debutteville und Cockerill in Seraing). E. Meyer. An illustrated account of the tests made on this large blowing engine, using blast furnace gases. 4500 w. Stahl und Eisen—July 15, 1900. No. 35886 D.

The Körting Exhibit at the Paris Exposition of 1900 (Die Elektrizität auf der Pariser Weltausstellung, Ausstellung der Firma Gebrüder Körting, Körtingsdorf bei Hannover). An illustrated general description of Körting gas engines directly connected to dynamos, on exhibition at Paris. 900 w. Elektrotech Zeitschr—July 26, 1900. No. 35808 B.

STEAM ENGINEERING.**Boiler.**

Borrot Multitubular Boiler (Chaudeère Multitubulaire Borrot). An illustrated description of a water-tube boiler in which the tubes cross each other in the form of an X, making a convenient arrangement and saving space. 2000 w. Revue Technique—May 25, 1900. No. 35828 D.

Chimneys.

New German Rules for the Stability of Chimneys. Translation of the rules and notes for calculating the stability and strength of masonry stacks, drawn up by the Society of German Engineers, the International Union of Boiler Insurance Societies, and a number of specialists. 2000 w. Eng Rec—Aug. 18, 1900. No. 36027.

Compound Corliss.

Compound Corliss Steam Engine at the Paris Exposition (Exposition de 1900.

Machine à Vapeur Compound Corliss à Soupapes). An illustrated description of a 240-horse-power engine, with special pop-valves on the high-pressure cylinder and ordinary Corliss valve-gear on the low-pressure. 1000 w. 1 plate. *Génie Civil*—July 14, 1900. No. 35879 D.

Condensers.

A Note on the Use of Condensers in Power Stations. R. C. Carpenter. On the saving as compared with non-condensing engines, and the two kinds of condensers. 700 w. *Am Elect'n*—Aug., 1900. No. 35663.

Distilling.

Test of Distilling Plant at Dry Tortugas. R. K. Crank. Report of a six-day trial of the "Lillie" multiple effect distilling plant, Jan. 13 to 20, 1900. Ill. 2000 w. *Ice & Refrig*—Aug., 1900. No. 35706 C.

Condensers and Economizers. Alton D. Adams. Discusses their advantages and examines the objections. 1700 w. *Elec Rev*, N. Y.—Aug. 22, 1900. No. 36054.

Explosions.

Boiler Explosions Discussed. T. R. Parker. Considers modern boilers less likely to burst, and discusses various types. 2000 w. *Am Mfr & Ir Wld*—Aug. 23, 1900. No. 36071.

Thoughts Suggested by Boiler Explosions. T. R. Parker. Read before the Pacific Coast Gas Assn. Discusses the medium employed; the agent; the character of the material; and forms and types of boilers, and means of avoiding conditions which cause explosions. Also general discussion. 6700 w. *Am Gas Lgt Jour*—Aug. 13, 1900. No. 35782.

Feed-Water.

Purification of Feed Water. J. A. F. Aspinall. Abstract of a report on the purification of feed-water for locomotive boilers, with short editorial. 2500 w. *R R Gaz*—Aug. 24, 1900. No. 36081.

Furnaces.

Furnace Efficiency. W. H. Booth. Considers things affecting the efficiency of a furnace, the importance of a fireman's duty and related matters. 1500 w. *Am Mach*—Aug. 16, 1900. No. 35958.

Indicator.

The Continuous Recording of Steam Engine Performance. Prof. William Ripper. A detailed exposition of Prof. Ripper's continuous mean-pressure indicator, with examples of its application to recent Cunard steamers. 3000 w. *Engineering Magazine*—Sept., 1900. No. 36169 B.

Keying.

Keying Up an Engine. W. H. Wakeman. Describes the writer's practice in

the engine room. 2000 w. *Engr*, U. S. A.—Aug. 15, 1900. No. 36022.

Paris Exposition.

Engines and Generators at the Paris Exposition. Illustrated description of some of the prominent exhibits. 2800 w. *Am Elect'n*—Aug., 1900. No. 35662.

Some Prominent Engines at the Paris Exposition. Illustrated detailed description of interesting engine exhibits. 5700 w. *Power*—Aug., 1900. No. 35645.

Pumping Engine.

Official Duty Tests of Pumping Engines Nos. 9 and 10, High-Service Station No. 3, St. Louis Water-Works, February 15-16 and 26-27, 1900. Nils Johnson. A summary of the results obtained and methods employed during the official duty tests of two 15,000,000-gallon, triple-expansion engines. 4400 w. *Jour Assn of Engng Socs*—July, 1900. No. 35985 C.

Test of a 30,000,000-Gallon Pump at Chestnut Hill, Boston. Gives the leading results of a 24-hour test of a triple-expansion engine, which developed 178,497,000-ft.-lbs. per thousand pounds dry steam. 600 w. *Eng Rec*—Aug. 4, 1900. No. 35726.

Superheating.

Saving by Superheated Steam. R. S. Hale, in *The Boiler*. Considers the value of superheating steam in reducing waste and describes three types of superheaters. 1600 w. *Ir & Coal Trds Rev*—July 27, 1900. No. 35729 A.

Trial.

Trial of an Allis Triple-Expansion Pumping Engine; Chestnut Hill Station, Boston Water-Works. Describes the plant and method of conducting the trial. Of interest because of the exceptional high duty attained. 2200 w. *Eng News*—Aug. 23, 1900. No. 36060.

MISCELLANY.

Abattoirs.

Municipal Abattoirs and their Mechanical Equipment (Städtische Schlachthöfe und deren Maschinelle Einrichtungen). Gustav Witz. An illustrated account of various machines, mechanical appliances and scientific methods used in slaughterhouse work. 5000 w. *Zeitschr d Oest Ing u Arch Ver*—July 13, 1900. No. 35892 B.

Aeronautics.

Preliminary Experiments in Long Distance Aerial Navigation (Essais Préliminaires à la Navigation Aérienne au Long Cours). Léo Dex. A well illustrated account of a balloon and auxiliary apparatus, including heavy guide-rope, used in ascensions, with a view to determining the conditions for remaining in the air a week or more. Serial. 1st part. 3000 w.

Revue Technique—May 10, 1900. No. 35826 D.

The Ascension of Count Zeppelin's Airship. An illustrated account of the ascension on July 2, 1900 w. Sci Am—Aug. 11, 1900. No. 35930.

The Ascension of the Zeppelin Air-Ship (Rundschau. Auffahrt des Zeppelinschen Luftfahrzeuges). The personal report of Count Zeppelin to the Council of the Gesellschaft zur Förderung der Luftschiffahrt. 700 w. Zeitschr d Ver Deutscher Ing—Aug. 4, 1900. No. 35876 D.

Brewing.

Progress in Brewing Machinery (Fort-schritte auf dem Gebiete der Brautechnik). H. Hempel. A paper before the Hessian branch of the Verein Deutscher Ingenieure, giving an illustrated description of modern machinery and methods used in brewing. Serial. 2 parts. 5000 w. Zeitschr de Ver Deutscher Ing—July 21, 28, 1900. No. 35870 each D.

China.

The Crisis in China. Its Meaning for Engineering Interests. Hon. John Barrett. Showing the identity of interests among the great industrial nations, with especial reference to the engineering development of the empire. 3000 w. Engineering Magazine—Sept. 1900. No. 36174 B.

Gun Carriage.

The Howell Disappearing Carriage. Illustrated detailed description of the machine and its operation, giving brief report of tests. 800 w. Sci Am—Aug. 25, 1900. No. 36047.

MINING AND METALLURGY

COAL AND COKE.

Australasia.

Australasian Coal. Concerning the advance in price and the output. 1200 w. Engng—Aug. 3, 1900. No. 35906 A.

British Coal Fields.

The British Coal Fields and Their Exhaustion (Die Britischen Kohlenlager und ihre Erschöpfung). Dr. Tübben. An abstract of a French book by Ed. Lazé, in which it is estimated that the British coal fields will be exhausted in the not very distant future. With an estimate of the coal supply of the other countries of the world. 4200 w. 3 plates. Glückauf—July 21, 1900. No. 35897 B.

Coke Ovens.

Welsh Coke Ovens. A brief description of a form of oven used in West Virginia in place of beehive ovens. 500 w. Mines & Min—Aug., 1900. No. 35684 C.

Ice Machines.

Vacuum Ice Machines. Alfred Siebert. Calculation of the theoretical economy. 1800 w. Ice & Refrig—Aug., 1900. No. 35707 C.

Mexico.

Three Large Franco-Mexican Industries in Mexico (Trois Grandes Industries Franco-Mexicaines au Mexique). Saint-Biey. An illustrated sketch of a cotton, a cigarette and a woolen factory, under the direction of French engineers. 2000 w. Revue Technique—June 25, 1900. No. 35832 D.

Paris Exposition.

Mechanical Engineering Exhibits at the Paris Exposition. Illustrates and describes some of the interesting exhibits, with comments. 3600 w. Eng News—Aug. 16, 1900. No. 35964.

Textile.

Machines for Textile Industries at the Paris Exposition (Die Weltausstellung in Paris 1900. Die Arbeitsmaschinen für die Textil-industrie). G. Rohn. An extended review of the machines used in textile industries, exhibited at Paris. Serial. 1st part. 7000 w. Zeitschr d Ver Deutscher Ing—July 28, 1900. No. 35871 D.

Weights.

The Inidikil System. A. Lincoln Hyde. Explains a decimal system of weights and measures for the English speaking people. 4300 w. Jour Assn of Engng Socs—July, 1900. No. 35984 C.

Coking.

Coking Plant of the Durham Coal & Coke Co. A. W. Evans. Illustrated description of a plant on Lookout Mountain, Georgia. 1300 w. Mines & Min—Sept., 1900. No. 36131 C.

Gob Workings.

Draining Gas from Gob Workings. Charles Connor. Considers the relative advantages of force and exhaust pans for this purpose. Also discussion. 7000 w. Mines & Min—Sept., 1900. No. 36135 C.

Inclines.

Transportation on Inclines. Edward H. Cox. Describes the methods of getting coal down the mountain from mine to tippie in West Virginia. 1200 w. Mines & Min—Aug., 1900. No. 35683 C.

Kebao.

The Collieries of Kebao, Tonking. Brief account of this island and its coal

deposits. Map. 1800 w. Ir & Coal Trds Rev—Aug. 3, 1900. No. 35798 A.

Mining Machinery.

Electric Mining Machinery in the British Collieries. Sydney F. Walker. Mr. Walker's second paper discusses the details of lighting, signaling and working of surface plant, with many illustrations of most recent devices. 4000 w. Engineering Magazine—September, 1900. No. 36170 B.

New Method.

Rib Drawing with Machines. W. S. Gresley. Illustrates and describes a proposed new method of mining coal by the use of longwall undercutting machines for taking out the rib. 2200 w. Mines & Min—Sept., 1900. No. 36138 C.

Paris Exhibition.

Blanzy Colliery at the Paris Exhibition. A description of the extensive exhibit of a half-size model of winding drum with tangential arms. 2200 w. Col Guard—Aug. 17, 1900. No. 36115 A.

Pictou, Col.

Coal Mines of Pictou. Frank Meade. A description of the mines of the Colorado Fuel & Iron Co., the methods of operation, and the geological formation. Ill. 2800 w. Mines & Min—Aug., 1900. No. 35679 C.

South Wales.

The Collieries of the Ebbw-Vale Company. Describes the characteristics of this coal field, and gives illustrated description of its various collieries. 3000 w. Ir & Coal Trds Rev—July 27, 1900. No. 35728 A.

Ventilation.

Resistance Opposed to Air-Currents by Wickets. Paul Petit. From a paper prepared for the International Congress at Paris. Considers the theory of the wicket, method of experimenting, and the results obtained. 2700 w. Col Guard—Aug. 17, 1900. No. 36116 A.

COPPER.

Deposits.

Glassford Creek Copper Mines. An account of the discovery of a rich deposit in Queensland, Aust. 1700 w. Aust Min Stand—July 12, 1900. No. 36020 B.

Lake Superior.

Lake Superior Copper Mines. H. J. Stevens. Discusses why the copper output does not respond as readily as the iron to an increase or decrease in price. 1200 w. Mines & Min—Sept., 1900. No. 36136 C.

New South Wales.

Copper Mining in New South Wales. Describes the work in the Mount Hope district. 1800 w. Aust Min Stand—June 21, 1900. No. 35695 B.

Supply.

Copper Supplies and Consumption. Editorial comment on copper prospects. 1400 w. Engng—Aug. 10, 1900. No. 36004 A.

United States.

The Great Copper Mines of the United States. From the *N. Y. Sun*. Interesting information concerning the great copper producing districts and their output. 800 w. Elec Rev, N. Y.—Aug. 22, 1900. No. 36055.

GOLD AND SILVER.

Alaska.

The Yukon and Nome Gold Regions. S. C. Dunham. A full account of these two gold fields and a comparison of the conditions and values. 20400 w. Bul Dept of Labor. July, 1900. No. 35916 D.

Assays.

Remarks on Assays and Samples. W. F. Robertson. Suggestions for securing accuracy in sampling and assaying. 1700 w. B. C. Min Rec—Aug., 1900. No. 35764 B.

Australasia.

The Australian Gold Yield. Reviews the production of the first half of the current year, reporting it as not realizing expectations. 1000 w. Aust Min Stand—July 12, 1900. No. 36019 B.

British Columbia.

Camp McKinney and Its Mines. Donald A. Ross. An illustrated account of the various mines and the development. 4000 w. B. C. Min Rec—Aug., 1900. No. 35762 B.

Howe Sound Division, New Westminster Mining District. W. M. Brewer. Report of personal examination made recently. 1500 w. Eng & Min Jour—Aug. 18, 1900. No. 35979.

California.

The Empire Mines, Past and Present. George W. Starr. Historical review. Ill. 1100 w. Min & Sci Pr—Aug. 4, 1900. Serial. 1st part. No. 35784.

Deposits.

Copper Deposits of the Ajo Basin, Gila Basin, Arizona. Arthur Lakes. A description of the country and its facilities in regard to the supply of fuel and water and timber necessary to operate the mines in that region. The large amount of mineral and difficulties of exploiting. 4500 w. Mines & Min—Aug., 1900. No. 35685 C.

Dredging.

Gold Dredging in British Columbia. R. Luid Watson. An illustrated description of the dredging plants and methods of operation used on the Fraser River. 2500 w. Mines & Min—Aug., 1900. No. 35682 C.

Notes on Gold Dredging. J. W. H. Piper. Read before the N. S. W. Chamber of Mines. An illustrated article, showing the great advantage of the bucket dredge as a gold producer. 1700 w. B. C. Min Rec—Aug., 1900. No. 35763 B.

Notes on Gold Dredging in New Zealand and New South Wales. J. W. H. Piper. Read at meeting of N. S. W. Chamber of Mines. Showing the immense advantage of the bucket dredge as a gold-producer. 1700 w. N. Z. Mines Rec—June 16, 1900. No. 35648 B.

Spoon and Grab Dredges. J. W. Jaffray. Read before the N. S. W. Chamber of Mines. Discusses the efficiency and economy of these dredges. 2800 w. Aust Min Stand—July 28, 1900. No. 35698 B.

Nevada.

The Ely Mining District, Nevada. Fred D. Smith. Describes a gold district of much promise. 1000 w. Eng & Min Jour—Aug. 25, 1900. No. 36076.

Newfoundland.

Notes on the Mineral Deposits of Newfoundland. William Scott. Reports briefly concerning the various minerals found and gives illustrations of the mines. 2100 w. Eng & Min Jour—Aug. 11, 1900. No. 35935.

New Mexico.

The Cochiti District, New Mexico. W. C. Wynkoop. Illustrates and describes this district, giving report of the mines, their output, value, etc. 2200 w. Eng & Min Jour—Aug. 25, 1900. No. 36075.

Nova Scotia.

The Metal Mines of Nova Scotia. Notes condensed from a monograph on the "Ores of Nova Scotia," by E. Gilpin, Jr. 2500 w. Eng & Min Jour—Aug. 11, 1900. No. 35936.

Oregon.

Ore Deposits in the Cracker Creek District, Oregon. T. L. Lammers. An account of the development of both placer and quartz mining, and the character of the deposits. 1300 w. Eng & Min Jour—Aug. 11, 1900. No. 35937.

Smelting.

Notes on Lead Smelting and Gold and Silver Refining. Malvern W. Iles. On the cost of smelting and refining at the Globe Works, Denver, Col. 2000 w. Eng & Min Jour—Aug. 18, 1900. No. 35976.

Silver Smelting in Mexico. Otto H. Hahn. Condensed extract from paper before the London Inst. of Min. & Met. A criticism of the method in operation at Smelter No. 3, of M. Guggenheim's Sons at Monterey, Mexico. 2000 w. Min & Sci Pr—July 28, 1900. Serial. 1st part. No. 35667.

South Carolina.

The Haile Gold Mines of South Caro-

lina. Arthur Lakes. An illustrated account of some striking peculiarities in regard to the ore bodies as compared with most western deposits. 3000 w. Mines & Min—Sept., 1900. No. 36134 C.

IRON AND STEEL.

Basic Steel.

On the Present Condition of the Manufacture of Basic Steel and Its Influence Upon That of Puddled Iron. M. G. Ro-cour. Abstract of a paper read before the Paris Min. and Met. Cong. Describes the present condition of this industry, and discusses the future outlook. 1500 w. Ir & Coal Trds Rev—July 27, 1900. No. 35730 A.

Blast Furnaces.

A New Method of Constructing Blast Furnaces. F. Burgers. Paper read before the Verein Deutscher Eisenhütten-leute. Describes a new system in which the shaft of the furnace is made of iron instead of fire-brick. Ill. 1800 w. Ir & Coal Trds Rev—July 27, 1900. No. 35727 A.

British Iron.

Glimpses of the British Iron Industry. An interesting review. 3000 w. Ir Age—Aug. 9, 1900. Serial. 1st part. No. 35922.

Corrosion.

The Relative Corrosion of Wrought Iron, Soft Steel, and Nickel Steel. Henry M. Howe. Abstract of paper read at International Cong. on Methods of Testing the Materials of Construction. 1500 w. Eng & Min Jour—Aug. 18, 1900. No. 35978.

Crystallography.

On the Crystallography of Iron. F. Osmond. A study of the crystallography of gamma-iron with interesting illustrations. 12500 w. Metallographist—July, 1900. Serial. 1st part. No. 35960 E.

Direct Process.

The Direct Production of Iron with a Definite Percentage of Carbon (Directe Eisengewinnung mit Bestimmtem Kohlenstoffgehalt). John Landin. A description of a process for producing iron direct from the ore, involving the preparation of briquettes containing ore, coal, lime and other ingredients. 1000 w. Oest Zeitschr f Berg u Hüttenwesen—July 14, 1900. No. 36150 B.

New Zealand.

Iron Ores and Lands of New Zealand. James Hector. Notes from the Handbook of New Zealand, 1886. 1800 w. N. Z. Mines Rec—July 16, 1900. No. 36139 B.

Open-Hearth.

Charging Apparatus for Martin Furnaces (Beschickungsvorrichtung für Mar-

tinöfen). An illustrated account of electrically driven carriage and charging machinery. 800 w. Stahl und Eisen—July 15, 1900. No. 35889 D.

Open-Hearth Steel Plant of the Alabama Steel & Shipbuilding Co., at Ensley, Ala. An illustrated detailed description of this important plant. 3200 w. Ir Trd Rev—Aug. 23, 1900. No. 36052.

Paris Exhibition.

Iron and Steel at the Paris Exhibition. Reviews the exhibits of the various countries. Ill. 32000 w. Ir & Coal Trds Rev—Aug. 10, 1900. No. 36008 A.

Rail Steel.

Rail Steel. The greater part of the reports for all countries, excepting the United States, at the International Railroad Congress. 2000 w. R R Gaz—Aug. 10, 1900. No. 35953.

Rolling Mills.

American Rolling Mills (Amerikanische Walzwerksanlagen). P. Eyermann. An illustrated description of some of the mills at Duquesne and Homestead, Pa., and the methods used there. 4000 w. Stahl und Eisen—July 15, 1900. No. 35887 D.

Specifications.

See Mechanical Engineering, Materials.

Steel Processes.

Recent Progress in Methods of Producing Steel (Die Neuen Fortschritte in der Flusseisenerzeugung). Fritz Lürmann, Jr. A paper before the Verein Deutscher Eisenhüttenleute, giving an illustrated account of improvements in converter and open-hearth processes; with the ensuing discussion. 11000 w. Stahl und Eisen—Aug. 1, 1900. No. 35890 D.

Sweden.

A Description of Some Little Known Iron Ore Deposits in Northern Sweden (Beschreibung einiger bisher wenig bekannter Erzkorkommen in dem Erzrevier von Jukkasjärvi (Schweden) und Umgebung). From an article by Walfr. Peterson in *Jernkontorets Annaler*, giving an account of the iron ores in the extreme north of Sweden. Serial. 2 parts. 2000 w. Glückauf—July 21, Aug. 4, 1900. No. 35899 each B.

Tool Steel.

See Mechanical Engineering, Machine Works and Foundries.

MINING.

Accidents.

Accidents in Coal Mines. Thomas K. Adams. A comparison between the coal production and number of accidents and their causes in different states and countries. 3800 w. Mines & Min—Sept., 1900. No. 36133 C.

Air-Pipes.

Loss of Load in Air-Pipes. Paul Petit. From a paper prepared for the International Cong. of Min. & Met. at Paris. Describes the mode of experimenting and gives the conclusions reached. Ill. 3500 w. Col Guard—Aug. 3, 1900. No. 35900 A.

Analysis.

Micro-Chemical Methods in Metallurgical Analysis. An outline of some micro-chemical reactions, and of methods of research in this new branch of chemistry. Ill. 4000 w. Col Guard—Aug. 10, 1900. No. 36011 A.

Fans.

The Practicable Scope of the Equivalent Orifice Theory. H. W. Halbaum. Discusses the work and results of M. Murgue in its application to fan tests. 4000 w. Col Guard—Aug. 17, 1900. No. 36114 A.

Fire Damp.

The Electric Spark in Coal Mines. Examines the question of the passage in mines where inflammable gas may be present, with the view of enabling mine managers to form an impartial opinion. Ill. 3200 w. Col Guard—July 27, 1900. No. 35712 A.

Leaks.

The Prevention of Leaks in Mines. L. C. Morganroth. On the importance of system and attention to little things. 1500 w. Mines & Min—Aug., 1900. No. 35681 C.

Mining Machinery.

See Coal and Coke.

Peru.

Peru's Mining Industries. H. L. Geissel. Facts in regard to the various ores and minerals and the extent to which they have been exploited. 2800 w. Mines & Min—Sept., 1900. No. 36137 C.

Pneumatophore.

The Practical Use of the Pneumatophore (Die Benutzung des Pneumatophors im Ernstfall). H. Lüthgen. An account of a mining accident, and the use of an apparatus containing oxygen, which is used for breathing when in an atmosphere of dangerous gases. 1500 w. 1 plate. Glückauf—July 14, 1900. No. 35896 B.

Pumping Engine.

The Kaselowsky Pumping Engine at Westphalian Collieries. Abstracted from a paper by C. François, in the *Revue Universelle des Mines*. Illustrated description of the system used. 800 w. Col Guard—Aug. 17, 1900. No. 36117 A.

Shaft Lining.

The Manufacture of Linings for Mine Shafts, at Garcy, France (Etude sur la Fabrication des Cuvelages de Puits de

Mines à Garcy, Meurthe-et-Moselle). E. Clère. An illustrated description of the manufacture of cast iron linings for shafts, in sections, with lead joints. 2400 w. 1 plate. Mem d l Soc d Ing Civils de France—No. 10, 1900. No. 35843 G.

Stores.

Mine Stores. F. Danvers Power. Abstract of paper read before the Aust. Inst. of Min. Engs. Suggestions for the ordering and distributing of mining stores, and the keeping of the accounts. 2500 w. Ir & Coal Trds Rev—Aug. 17, 1900. No. 36107 A.

Timbering.

Mine Timbering. David J. Evans. Read before the Indiana Min. Inst. Presents various ways of cutting and placing timbers to secure the best results. 1600 w. Mines & Min—Aug., 1900. No. 35688 C.

Wages.

Miners' Wages in the Pennsylvania Anthracite Mines. Concerning the changed conditions, explaining why many mines have been operated at a loss, and features of the wage scale. 1500 w. Eng & Min Jour—Aug. 25, 1900. No. 36074.

MISCELLANY.

Alloys.

Magnalium. Translated from *Neueste Erfindungen und Erfahrungen*. An interesting description of a new alloy, composed of aluminum and magnesium. 1800 w. Ir Age—Aug. 23, 1900. No. 36035.

Aluminum.

The Generation of Intense Heat Through the Combustion of Aluminum. S. B. Archdeacon. Describes the process, based on the affinity of aluminum and oxygen, noting some of its applications. Ill. 3600 w. Eng & Min Jour—Aug. 25, 1900. No. 36077.

Carborundum.

Carborundum. L. J. Gray. An account of the discovery, the development of the manufacture, the remarkable properties, etc. Ill. 2000 w. Foundry—Aug., 1900. No. 35674.

Congress.

The Congress of Mines and Metallurgy at the Paris Exposition (Congrès des Mines et de la Metallurgie). Gérard Lavergne. An abstract of the proceedings of this congress, held June 18 to 23. 3500 w. Génie Civil—Aug. 4, 1900. No. 35885 D.

Cornwall.

The Decaying Mining Industries of Cornwall. From the annual report of J. S. Martin, inspector. An account of present conditions, with tables showing the fluctuations in the price of tin since 1850. 1900 w. Ir & Coal Trds Rev—Aug. 10, 1900. No. 36007 A.

Lead.

Note on the Metallurgy of Lead in Murcia, Spain (Note sur la Metallurgie du Plomb dans la Province de Murcie, Espagne). P. Jannettaz. A general description of the region, the lead ores, galena particularly, and their metallurgical treatment. 2000 w. Mem d l Soc d Ing Civils de France—No. 12, 1900. No. 35848 G.

Leadville.

The Fourth Era of the Leadville Mining District. Thomas Tonge. A review of the successive stages of the Leadville district with especial reference to the development, not only of gold and silver, but also of copper, iron, zinc, and bismuth. 4000 w. Engineering Magazine—Sept., 1900. No. 36173 B.

Lead-Zinc.

The Lead and Zinc Industry of Southwest Missouri. F. W. Draper. Read before the Ap. Sci. Soc. of McGill Univ. Describes the deposits, discussing their origin, and the methods of mining and preparation for market. 2100 w. Can Engr—Aug., 1900. No. 35786.

Mexico.

Mines of Velardena, Mexico. Ernest E. Payne. A history and illustrated description of some little known, but productive, mines, which have been worked for centuries. 1400 w. Mines & Min—Sept., 1900. No. 36132 C.

New South Wales.

Metals and Minerals of New South Wales. J. E. Carne. Report on the mineralogical deposits occurring in the high tableland between Tumut and Kiandra. 2200 w. Aust Min Stand—June 21, 1900. No. 35096 B.

Mines and Minerals of New South Wales. W. H. J. Slee. On the resources and development of the Inverell and Tingha districts. 2600 w. Aust Min Stand—June 28, 1900. No. 35697 B.

Ores.

Magnetic Preparation of Ores. M. Smits. From a paper prepared for the International Congress at Paris. An illustrated description of the Wetherill process. 1700 w. Col Guard—July 27, 1900. No. 35713 A.

Paris Exhibition.

Mechanical Preparation Plant at the Paris Exhibition. Illustrated description of preparation appliances shown in the French section, for crushing, sizing, etc. 2200 w. Col Guard—Aug. 10, 1900. No. 36013 A.

Petroleum.

The Distribution and Production of Mineral Oil (Ueber die Verbreitung und die Produktion des Erdöls unter beson-

derer Berücksichtigung der für Deutschland Wichtigsten Produktionsgebiete). Prof. Oebbeke. Abstract of an address before the Munich Polytechnischer Verein, in which the subject is treated generally, and particular attention called to the Carpathian oil fields, in Central Europe. 2400 w. Glückauf—July 28, 1900. No. 35898 B.

Quarrying.

Quarrying by the Helicoidal Wire. N. Pellati. From a paper prepared for the International Congress, at Paris. Describes the method and its advantages. 1000 w. Col Guard—Aug. 17, 1900. No. 36118 A.

Ruby Mines.

The Burma Ruby Mines. An account of the work at these mines, which are now working on a paying basis. 1000 w. Eng & Min Jour—Aug. 18, 1900. No. 35977.

Salt Lake.

Great Salt Lake and Its Waters. Don Maguire. A history of the early exploration that led to its discovery, and an account of an expedition upon it in 1891. 6500 w. Mines & Min—Aug., 1900. No. 35680 C.

Siberia.

Mineral and Agricultural Resources of Siberia. Translation from a recently published book by Baron de Batz, giving information about the gold-bearing strata,

climate, etc. 2800 w. U. S. Cons Repts, No. 808—Aug. 15, 1900. No. 35917 D.

Tin.

Cornish Tin Mining. Considers reasons why this industry has not revived with the rise in the price of this metal. 1800 w. Engr, Lond—Aug. 17, 1900. No. 36113 A.

Zinc.

Improvements in the Metallurgy of Zinc. J. Ohly. Reviews the past methods and describes the improved process invented by Dr. Lungwitz and Dr. Schupphaus. 1700 w. Min Rept—Aug. 2, 1900. No. 35744.

Researches on the Influence of the Degree of Desulphuration of Blende upon the Yield of Zinc (Recherches sur l'Influence du Degré de Désulfuration des Blendes sur le Rendement en Zinc à la Réduction). Eugène Prost. An account of experiments which show the importance of care in roasting zinc sulphides. 2000 w. Rev Universelle des Mines—March, 1900. No. 35867 F.

The Metallurgy of Zinc. H. Van F. Furman. Discusses the physical and chemical properties, ores, methods of reducing, dry and wet processes, etc. 5800 w. Mines & Min—Aug., 1900. Serial. 1st part. No. 35687 C.

Zinc Smelting at Cañon City. Illustrates and describes an interesting plant for ore reduction. 1300 w. Min Rept—Aug. 23, 1900. No. 36129.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in June. Detailed list and classified summary. 4500 w. R. R. Gaz—Aug. 17, 1900. No. 35970.

Madagascar.

Ways of Communication and Methods of Transportation in Madagascar (Commission des Etudes Coloniales. Voies de Communication et Moyens de Transport à Madagascar). J. J. Marié. A general review of present systems on the island and proposed improvements, with maps. 10000 w. 1 plate. Mem d l Soc d Ing Civils de France—No. 9, 1900. No. 35842 G.

Southern Railway.

Evolution of the Southern Railway. An account of the progress during the last six years. 1800 w. R R Gaz—Aug. 17, 1900. No. 35974.

Tramp Problem.

Railroad Police Organization and the

Tramp Problem. Josiah Flynt. Read before the Cent. Assn. of R. R. Officers. An account of the great number of tramps continually on the railroads, and the history of the police service in vogue on one important railroad. 3500 w. St. Louis Ry Club—Aug. 10, 1900. No. 36092.

FINANCIAL.

American Railroads.

American Railroads. George H. Daniels. An interesting discussion of their relation to commercial, industrial and agricultural interests. 5000 w. St. Louis Ry Club—Aug. 10, 1900. No. 36091.

MOTIVE POWER AND EQUIPMENT.

Air-Brake.

Reports on the Lipkowski Compressed-Air Brake (Rapports au Comité de l'Exploitation Technique des Chemins de Fer sur le Frein à Air Comprimé, Système Lipkowski). E. Vicairc. French official reports, giving the results of trials on French railways, which were satisfactory,

on the whole. 8000 w. Ann d Ponts et Chaussées—1st quarter, 1900. No. 35860 E + F.

Compartment Car.

First-Class Compartment Car—Paris, Lyons & Mediterranean Railway. Illustrations with brief description. 400 w. R R Car Jour—Aug., 1900. No. 35921.

Dining Cars.

Southern Railway Dining Cars. Brief description, with plan. 900 w. Ry Age—Aug. 3, 1900. No. 35742.

Dining Trains.

New Corridor Dining Trains on East Coast Route to Scotland. Charles Rous-Marten. Describes the train and the trial trip. 2000 w. Engr, Lond—Aug. 3, 1900. No. 35913 A.

Draft Gear.

The Sessions-Standard Friction Draft Gear. Illustrated description with report of tests. 1400 w. R R Gaz—Aug. 17, 1900. No. 35972.

Draft Rigging Test.

Interesting Draft Rigging Test. An account of tests made at Lima, O., on draft rigging, devised by Clement F. Street. Ill. 2200 w. Ry & Engng Rev—Aug. 11, 1900. No. 35927.

Feed Water.

On "Pure Water for Locomotives by Evaporation." C. Herschel Koyl. Discusses articles bearing on this subject and favors the purifying of the water by chemical means as far cheaper. Ill. 1500 w. R R Gaz—Aug. 17, 1900. No. 35971.

Firebox.

Problems the Wide Firebox Solves. J. S. S. Fulton. On the merits of large grates. 1500 w. Am Engr & R R Jour—Aug., 1900. No. 35643 C.

Heating.

The Heating of Railway Carriages. Discusses the details in connection with the distribution along the length of the train when steam heating is used. 2200 w. Engr, Lond—Aug. 3, 1900. No. 35909 A.

Locomotives.

Austrian Locomotives at the Paris Exhibition. Illustrates and describes the exhibit of the Actien-Gesellschaft der Locomotiv-Fabrik, Wiener-Neustadt. 800 w. Engng—Aug. 17, 1900. No. 36103 A.

Boiler and Frames—Twelve-Wheel Freight Locomotive. Illustrates and describes these features in a large engine for the Illinois Central R. R. 600 w. Am Engr & R R Jour—Aug., 1900. No. 35642 C.

Consolidation Locomotives for the Rio Grande Western Ry. Illustrated detailed description of a large and powerful en-

gine. 1000 w. Eng News—Aug. 30, 1900. No. 36146.

Four-Cylinder Locomotive. Illustrated detailed description of a fine engine in service on the Glasgow & South-Western Ry. 600 w. Engng—Aug. 10, 1900. No. 36003 A.

Four-Wheel Coupled Locomotive at the Paris Exposition. Illustrated description of an interesting engine, built for drawing heavy loads at a relatively high speed for long distances without stopping. 1000 w. Engng—Aug. 3, 1900. No. 35907 A.

Locomotive Exhibits at the Paris Exposition. Charles Rous-Marten. An expert review of the leading exhibits, showing the principal tendencies of modern practice. Serial. Part I. 3000 w. Engineering Magazine—Sept., 1900. No. 36168 B.

Some of the Recent Passenger Locomotives of the Pennsylvania Railroad. Illustrates 10-wheel and 8-wheel locomotives, giving information concerning them. 300 w. R R Gaz—Aug. 10, 1900. No. 35950.

Ten-Wheel Passenger Locomotives. Brief illustrated description of one of the ten locomotives built for the Finland State Railways. 350 w. Am Engr & R R Jour—Aug., 1900. No. 35644 C.

Yard Locomotive, Central London Railway. Sectional drawings with brief description. 400 w. Engr, Lond—Aug. 3, 1900. No. 35911 A.

Locomotive Works.

See Mechanical Engineering, Machine Works and Foundries.

Sleeping Car.

The First Japanese Sleeping Car. Willard C. Tyler. Views of a car built in Japan and put in service on the Sanyo Ry., with description. 600 w. Ry & Engng Rev—Aug. 11, 1900. No. 35926.

Snow Plows.

Machine Snow Plows on the Colorado Midland Ry. Gives the results on this road in trials of the two kinds of excavators used in this country. 1500 w. Eng News—Aug. 23, 1900. No. 36066.

Standards.

Standards of, and Practices Approved by, the Master Mechanics' Association. Information extracted from the report presented at the Saratoga convention. 2000 w. Ry Mas Mech—Aug., 1900. No. 35777.

Steel Cars.

Pressed Steel Cars for France. Illustrations showing the construction and general dimensions of 100 flat-bottom gondola cars being shipped to the Paris, Lyons & Mediterranean Railroad Co., of France. 800 w. R R Gaz—Aug. 10, 1900. No. 35951.

Summers' 100,000 lbs. Capacity Steel Hopper Car. An illustrated detailed description of a new design. 1000 w. Ry & Engng Rev—Aug. 25, 1900. No. 66102.

Superheating.

Super-Heated Water Motor for Railroad Traction. An illustrated explanation of a system which is being tested on the New York & Putnam Railway. 1900 w. Sci Am—Aug. 25, 1900. No. 36046.

Test Car.

Test Car of the Illinois Central Railroad and the Railway Mechanical Engineering Department of the University of Illinois. Edward C. Schmidt. Illustrated description of the car and its equipment. Designed for general railroad experimental work. 1200 w. Am Engr & R R Jour—Aug., 1900. No. 35641 C.

Train Lighting.

Electricity Versus Gas for Train Lighting. Alton D. Adams. Favors electricity, considering it safer and less costly. 1600 w. W Elect'n—Aug. 11, 1900. No. 35941.

Valve.

A New Triple Valve. Illustrated description of a new triple valve and high-speed brake attachments, patented by M. W. Hibbard. 1200 w. R R Gaz—Aug. 10, 1900. No. 35952.

NEW PROJECTS.

Extension.

The Lanarkshire and Ayrshire Railway Extension. Abridged from the *Glasgow Evening Citizen*. Describes a new extension to expedite mineral traffic. 1500 w. Transport—Aug. 3, 1900. No. 35793 A.

Great Northern.

Great Northern Railway—New Railway at Nottingham. R. F. Bennett. An account of an expensive connecting line of first-class character. Ill. 2400 w. Engr, Lond—Aug. 17, 1900. Serial. 1st part. No. 36112 A.

Improvements.

Improvements on the Cincinnati Southern Ry. Illustrates and describes the work of building a new line around tunnel No. 27, and other improvements. 1000 w. Ry & Engng Rev—Aug. 18, 1900. No. 36023.

India.

Indian Railway Enterprise. Editorial on recent progress and improvement. 1000 w. Engng—Aug. 17, 1900. No. 36105 A.

Mexico.

Railway Contract in Mexico. A copy of the contract relating to the Tehuantepec Railroad and the ports of Coatzacoalcos and Salina Cruz. 1100 w. U. S. Cons Repts, No. 805—Aug. 11, 1900. No. 35761.

Panama.

Concerning the Panama Railroad. George Hebard Paine. Describes the road and its equipment, and gives related information. 1600 w. R R Gaz—Aug. 17, 1900. No. 35969.

Russo-Chinese.

A New Russo-Chinese Railroad Scheme—Samarkand to Hankow. From the Moscow *Russian Gazette*. Concerning a road into the interior of China for the benefit of Russian foreign trade with the East. 700 w. R R Gaz—Aug. 10, 1900. No. 35954.

Siberian Railway.

The Siberian Railway. Interesting details taken from the survey drawn up for the Paris Exhibition by the Imperial Commission. Map. 1500 w. Engr, Lond—Aug. 3, 1900. No. 35915 A.

Spain.

Railways in Spain. Information concerning the principal corporations, the difficulties in the way of construction, the projected lines, equipment, etc. 1500 w. U. S. Cons Repts, No. 801—Aug. 8, 1900. No. 35760 D.

Transbaikal.

The Transbaikai Hei-lun-Zagan Railway. Interesting details relating to this section, and some of the problems met. 1800 w. Engng—Aug. 10, 1900. No. 36005 A.

PERMANENT WAY AND FIXTURES.

Gates.

Railway Crossing Gates with Pipe Connections. Illustrates and describes a gate operated by pipe connections and levers similar to those of an interlocking plant. 450 w. Eng News—Aug. 23, 1900. No. 36070.

Grade Crossings.

Highway Grade Crossing Alarms. J. S. Evans. Read before the Assn. of R. R. Tel. Supts. Discusses the protection by automatic alarms, the reliability, cost, etc. 1200 w. Eng News—Aug. 30, 1900. No. 36149.

Mileage.

The Great Railway Systems—Present Rank by Mileage. Gives a tabulated list of all railway companies of the United States and Canada, which control over 2,000 miles of lines, with related information. 1100 w. Ry Age—Aug. 3, 1900. No. 35741.

N. Y. Central.

Permanent Way of the New York Central. Diagrams as condensed from records made by Mr. Dudley's Apparatus, with remarks. 1100 w. R R Gaz—Aug. 3, 1900. No. 35671.

The New York Central's Improvements

at Weehawken. Plans of the proposed reorganization of a great terminal freight yard, with several additional piers, and eventually a new grain elevator. 1000 w. Ry Age—Aug. 10, 1900. No. 35919.

Rail Fastening.

The Albert Collet System of Fastening Rails to Cross Ties (Rapports de M. Ed. Sauvage, sur les Attaches de Rails de M. A. Collet). A report on methods and tools used. A hardwood treenail is screwed into the tie and the fastening screw is screwed into the treenail. Well illustrated. 2000 w. Bull d l Soc d'Encouragement—June 30, 1900. No. 35864 G.

Rails.

Recent Practice in Rails. An informal discussion by Robert W. Hunt and A. L. Colby. 9500 w. Pro Am Soc of Civ Eng—Aug., 1900. No. 36098 E.

Some Peculiarities of Steel Rails. Photographic examination of sections etched by dilute sulphuric acid, as given in an appendix to the report of the committee appointed by the British Board of Trade. 600 w. Ir & Coal Trds Rev—Aug. 3, 1900. No. 35799 A.

The Qualities and Life of Rails. Synopsis of the report of a committee appointed by the British Board of Trade to inquire into this question, with brief comment. 2400 w. R R Gaz—Aug. 3, 1900. No. 35672.

The Life of Steel Rails. An article giving results of experience. Discusses tramways, pavements, railways, and gives a comparison of methods of laying tramway and railway tracks. 5400 w. Engr, Lond—July 27, 1900. No. 35737 A.

Railway Bridges.

See Civil Engineering, Bridges.

Signals.

The Timmis-Lavezzari Automatic Electric Signal System (Signaux Electriques Automatiques Systeme Timmis-Lavezzari). A. Lavezzari. An illustrated description of the system as applied on the

electric railroad at the Paris Exposition of 1900. 1600 w. Mem d l Soc d Ing Civils de France—No. 8, 1900. No. 35841 G.

Union Automatic Signals on the Lackawanna. A diagram showing the arrangement of signals. The signals are semaphores, worked by electric motors. 600 w. R R Gaz—Aug. 10, 1900. No. 35949.

Tie Plates.

A Tie-Plate Setting and Surfacing Gage. Illustrated description of a tool for securing accurate work and its time record. 900 w. Eng News—Aug. 2, 1900. No. 35692.

Track Construction.

Standards of Track Construction on American Railways. Gives tabulated statements representing the standard practice now in force in the United States, Canada and Mexico, with other information, and editorial comment. 8000 w. Eng News—Aug. 30, 1900. No. 36144.

Track Inspection.

A Graphical Registering Method for Railway Track Inspection (Méthode Graphique pour la Reconnaissance et la Vérification du Tracé des Voies de Chemins de Fer). M. Desdouts. An illustrated description of work with a pendulum registering apparatus, which records all the features of the track when run over it on any kind of vehicle. 8000 w. 2 plates. Ann d Ponts et Chaussées—4th quarter, 1899. No. 35852 E + F.

Tunnels.

See Civil Engineering, Construction.

TRAFFIC.

American Railways.

Passenger Traffic and Passenger Profits on American Railways. Editorial discussion of the difficulties in conducting passenger traffic on a paying basis. 3000 w. Eng News—Aug. 16, 1900. No. 35965.

STREET AND ELECTRIC TRAMWAYS

Brakes.

An Electric Brake for Trailer Cars (Elektrische Bremse für Anhängewagen). Dr. A. Krebs. An illustrated description of an electric brake of simple mechanical construction, made by the Allgemeine Electricitäts Gesellschaft. 500 w. Elektrotech Zeitschr—July 19, 1900. No. 35804 B.

Tests of Street Car Brakes by the New York Railroad Commission. Descriptions of the brakes tested which met the requirements. 4800 w. Eng News—Aug. 2, 1900. No. 35691.

Tests of Street Car Brakes in New

York. Editorial pointing out some of the defects of the tests and records made by the New York Railroad Commission. 1100 w. R R Gaz—Aug. 10, 1900. No. 35955.

City Traffic.

Grounded Cars and Dead Rails. E. C. Parham. Discusses these troubles and the way to start the car without danger. 1000 w. Am Elect'n—Aug., 1900. No. 35666.

Combined System.

The Bois de Boulogne Combined Trolley and Surface Contact Tramway. Illustrates and describes the line and its operation. 2000 w. Elec Rev, Lond—Aug. 17, 1900. No. 36125 A.

Compressed Air.

Compressed Air Cars in New York. An account of the change being made in the motors of the Twenty-eighth and Twenty-ninth street lines in New York City, explaining the reason of the change. Ill. 2500 w. St Ry Jour—Aug. 4, 1900. No. 35775 D.

Conduit Roads.

Note on American Electric Conduit Tramways (Note sur les Tramways Electriques Americains a Prise de Courant par Caniveau Souterrain). M. Mesnager. A description of the New York and Washington conduit roads, with map, and illustrations of yokes, etc. 6000 w. 1 plate. Ann d Ponts et Chaussées—4th quarter, 1899. No. 35850 E + F.

Controller.

The Auvert Compressed-Air Motor for Controlling Electric Trains (Servo-Moteur Auvert). Ch. Baudry. An illustrated description of a system of operating the individual electric controllers on the cars of an electric train, by a compressed-air master motor at one point and secondary motors on the cars. 2200 w. 1 plate. Mem d l Soc d Ing Civils de France—No. 8, 1900. No. 35840 G.

Electrolysis.

Electrolysis in Providence, R. I. Illustrated description of an investigation by A. A. Knudson, one of the cuts showing the effect of electrolysis on the interior of pipes. 3400 w. Eng Rec—Aug. 4, 1900. No. 35722.

English Line.

Description of the Blackpool and Fleetwood Tramroad and Generating Station. Tom. G. Lumb. Describes the permanent way, distributing system and rolling-stock. 3300 w. Elec Engr, Lond—Aug. 10, 1900. No. 36018 A.

English Railway.

Electric Railway in Birmingham. An account of difficulties in tramway matters, and of an experimental overhead electric trolley system. 1500 w. U. S. Cons Repts, No. 815—Aug. 23, 1900. No. 36050 D.

Exhibition.

The International Tramways and Light Railways Exhibition. Complete illustrated description of the exhibition held at the Royal Agricultural Hall, Islington, London, N., from June 22 to July 4. 25000 w. Tram & Ry Wld—Aug. 9, 1900. No. 36178 A.

Flanges.

Wheel Flanges and Rail Grooves. William Glenn Keagey. Discussion of the causes of the breaking of wheel flanges, and the remedy. Ill. 1000 w. Tram & Ry Wld—Aug. 9, 1900. No. 36177 A.

Glasgow.

The Electric Equipment of Glasgow Tramways. An illustrated detailed description of this extensive three-phase system. 6500 w. Tram & Ry Wld—Aug. 9, 1900. No. 36175 A.

Havana.

The Electric Railways of Havana. Illustrated detailed description of the line now in course of construction and the equipment. 2000 w. St Ry Jour—Aug. 4, 1900. No. 35776 D.

Improvements.

Recent Improvements in the Southwest Missouri Electric Railway System. Illustrated detailed description of the equipment and operation of an interurban railway. 2800 w. St Ry Jour—Aug. 4, 1900. No. 35769 D.

Indiana.

The System of the Indiana Railway Co. An illustrated detailed description of the lines, with review of the history. 8000 w. St Ry Rev—Aug. 15, 1900. No. 35992 C.

Liverpool.

Liverpool Corporation Tramways. Illustrated description of the construction and equipment. 1300 w. Tram & Ry Wld—Aug. 9, 1900. No. 36176 A.

London.

New Electric Tramway Schemes for London. Extracts from the report of the Highways Committee concerning the proposed new tramways north and south of the Thames. 2000 w. Elec Rev, Lond—Aug. 3, 1900. No. 35790 A.

Manhattan Elevated.

The Electrical Equipment of the Manhattan Elevated Railway. Progress and details of this important installation. 1200 w. Elec Rev, N. Y.—Aug. 1, 1900. No. 35694.

Motor Cars.

The Development of Motor Cars for Electric Tramways (Die Entwicklung des Motorwagens für Elektrische Strassenbahnen). Max Stobrawa. A paper before the Elektrotechnische Gesellschaft at Cologne, giving a historical review of motor cars, with examples of present types. Serial. 1st part. 2200 w. Elektrotech Rundschau—Aug. 1, 1900. No. 35821 B.

Paris Exposition.

Electric Transportation at the Paris Exposition (Der Elektrische Verkehr auf der Ausstellung in Paris 1900). An illustrated account of the traveling sidewalk and the electric railway inside the Exposition grounds. 2000 w. Oest Monatschr f d Oeff Baudienst—Aug., 1900. No. 36152 G.

Paris Exposition Notes. Illustrated description of some of the railway and

tramway exhibits. 1500 w. St Ry Jour—Aug. 4, 1900. No. 35774 D.

Transportation at the Paris Exposition (Die Weltausstellung in Paris 1900. Das Verkehrswesen). Dr. J. Kollmann. A criticism of the transportation exhibit, and general description of local transportation about the Exposition, particularly of the moving sidewalk. Serial. 1st part. 4000 w. Zeitschr d Ver Deutscher Ing—July 21, 1900. No. 35869 D.

Paris Metropolitan.

The Metropolitan Railway of Paris (Chemins de Fer. Le Métropolitain de Paris. Description Générale du Réseau Projeté. Description Détaillée de la Partie Exécutée). A. Dumas. An elaborately illustrated description of this fine underground road, part of which is now in operation, and its construction. 16000 w. 5 plates. Génie Civil—July 21, 1900. No. 35881 D.

The Metropolitan Railway of Paris. An outline of the main features of this subway system, now $6\frac{3}{4}$ miles long, but planned to be $48\frac{1}{2}$ miles. 1000 w. Eng Rec—Aug. 11, 1900. No. 35752.

The Paris Metropolitan Underground. A very complete illustrated account of the road and equipment. 1500 w. Elec Wld & Engr—Aug. 11, 1900. No. 35933.

Potential.

Fall of Potential Along Tramway Rails. E. Parry. A study of this problem of current distribution. 2000 w. Elect'n, Lond—Aug. 10, 1900. No. 35999 A.

Power Station.

The Ninety-Sixth Street Power Station of the Metropolitan Street Railway Company, of New York City. L. G. Montony. Illustrated detailed description. 7000 w. Pro Am Soc of Civ Engs—Aug., 1900. No. 36093 E.

Prague.

The Electric Generating System of Prague. Fred. Bathurst. Illustrated detailed description. 2000 w. Elec Rev, Lond—Aug. 17, 1900. Serial. 1st part. No. 36124 A.

Protection.

Protection of Telegraph and Telephone Wires in Connection with Overhead Traction. R. C. Quin. Read before the Munic. Elec. Assn. at Leeds, Eng. Brief paper discussing the usual practice. 1500 w. Elect'n, Lond—Aug. 10, 1900. No. 36001 A.

Repairing.

Testing and Repairing Methods of the North Jersey Street Railway Company. Illustrated description of the methods used at the Plank Road repair shop in Newark, N. J. 1400 w. St Ry Jour—Aug. 4, 1900. No. 35771 D.

Resistance.

Concerning Tractive Resistances. An article discussing the uncertain factors in train resistances at the high speeds to which electric traction tends. 1800 w. St Ry Jour—Aug. 4, 1900. No. 35773 D.

Safety Rules.

Safety Regulations for Electric Railway Plants (Sicherheitsregeln für Elektrische Bahnanlagen). The provisional regulations adopted by the Verband Deutscher Elektrotechniker for electric railways; and also those for theatres and for show windows and other places containing inflammable material. 4000 w. Elektrotech Zeitschr—Aug. 2, 1900. No. 35816 B.

Small Railways.

Can Small Electric Railways Be Operated at a Profit? James Blake Cahoon. Part first discusses conditions in small towns and means of increasing the patronage of the roads. 4800 w. St Ry Jour—Aug. 4, 1900. Serial. 1st part. No. 35772 D.

Subways.

Proposed Plans for Chicago Subways. Brief illustrated description of six subway loops to take cars of the street railway lines entering the business portion of the city. 1400 w. W Elect'n—Aug. 18, 1900. No. 35995.

Switzerland.

The Street Railway System of Geneva, Switzerland. An illustrated article giving points of interest in the construction and operation of an extensive system. 4000 w. St Ry Jour—Aug. 4, 1900. No. 35770 D.

Traction Meter.

See Electrical Engineering, Measurement.

Tramway Systems.

Conduit v. Trolley. J. Clifton Robinson. Opposing the construction of the costly conduit in London. 1400 w. Elec Engr, Lond—Aug. 10, 1900. No. 36017 A.

Transportation.

Trolley, Steam and Third Rail in Connecticut. Clarence Deming. Reviews the past ten years and the changes affected by improved facilities in transportation, touching upon the rivalries, and signs of progress. 2500 w. R R Gaz—Aug. 10, 1900. No. 35948.

Underground.

Electric Underground Railway in London. A description taken from the London Times. 1600 w. U. S. Cons Repts, No. 796—Aug. 2, 1900. No. 35654 D.

The Whitechapel and Bow Railway. Brief description of what will probably be the last steam underground railway of London. 1200 w. Engr, Lond—July 27, 1900. No. 35738 A.



VOL. XX.

NOVEMBER, 1900.

No. 2.

THE LOADING AND CARRIAGE OF SEA-BORNE COAL.

By F. Seaton Snowden.



SEA-BORNE coal, as shown by the records, formed an item in the trade of London as far back as the year 1228. The coal referred to in these records was brought from Newcastle and landed at Jacobs Lane, in the "Fleet." This is the first evidence we have of the use of Northumbrian coal in the south of England.

In 1849, or three years before the first steam collier, the John Bowes, commenced to ply between the Tyne and the Thames, the total importation of sea-borne coal into London was 3,418,000 tons. This figure had increased to 7,288,000 tons in 1898, in which year the United Kingdom exported 36,562,796 tons of coal, coke, and patent fuel, valued at £18,135,502, the total output of the country during the year being 203,054,516 tons. How these totals had grown and still continue to grow may perhaps be better realised when it is stated that thirty years ago a Royal Commission reported that in the previous

A homely Spanish proverb reads that "In eating and scratching, everything is the beginning." So it is often in the larger feeding upon foreign supplies. Currents of export trade, once started, gather volume as they move and soon become settled channels. This is likely to prove true in the yet new export of American coals. Every sign points to the early transfer, to transoceanic business, of the attention and the appliances heretofore chiefly devoted to American lake traffic. The situation lends particular interest to this review of the situation by an impartial authority, especially when joined with a display of the results already attained in the United States in the movement of coal cargoes under conditions practically identical with those governing Transatlantic freight business.—THE EDITORS.

Copyright, 1900, by John R. Dunlap.

year, 1869, the total quantity of coal raised in Great Britain was but 107,427,537 tons, of which 9,775,470 tons were exported and 3,277,562 tons were used for "purposes of steam navigation," in other words, as bunkering fuel. Coming now to the latest figures available, we find that the coal output for the United Kingdom in 1899 is given as 220,085,000 tons, and the exports, including bunkers and coke, at 55,335,369 tons. The total coal exported last year by Great Britain was 41,180,300 tons, valued at £23,105,691, a further 12,226,801 tons being supplied for the bunkers of steamers engaged in foreign trade.



NEW DOCK OFFICE AT CARDIFF, THE GREAT SHIPPING PORT FOR WELSH COALS.

According to the figures supplied by the United States Geological Survey, the output of coal in the States last year was 196,405,935 "long" tons. The British Board of Trade is a little more generous in the matter and credits American pits with an output last year of 218,376,000 tons. However that may be, there appears to be no reason to doubt the figures referring to the United States export of coal during last year, which are given at 5,752,150 long tons, valued at \$15,713,376, or roughly, £3,145,000.

Combining these figures for 1899, we find that the two great coal-producing countries of the world (the English and American returns account for fully 60 per cent. of the whole world's output during 1899), sent afloat in the period indicated cargoes of coal representing in the aggregate no less than 46,932,450 tons in weight and £26,250,-

691 in value. If to this we add coke and patent fuel and the coal and coke exported by other countries, it will be well within bounds to say that over 1,200,000 tons of fuel were shipped every week of the past year.

The magnitude of this trade and the volume of shipping that it gives employment to can best be realised when we remember that even at this end of the nineteenth century there are but very few of our ocean colliers that lift over 7,000 tons of cargo. Luckily, however, the modern "self-trimmer" will take in coal much more rapidly than any general cargo can be shipped. As an instance, with the Lewis-Hunter patent coaling cranes, as used at Cardiff, not only has the speed of

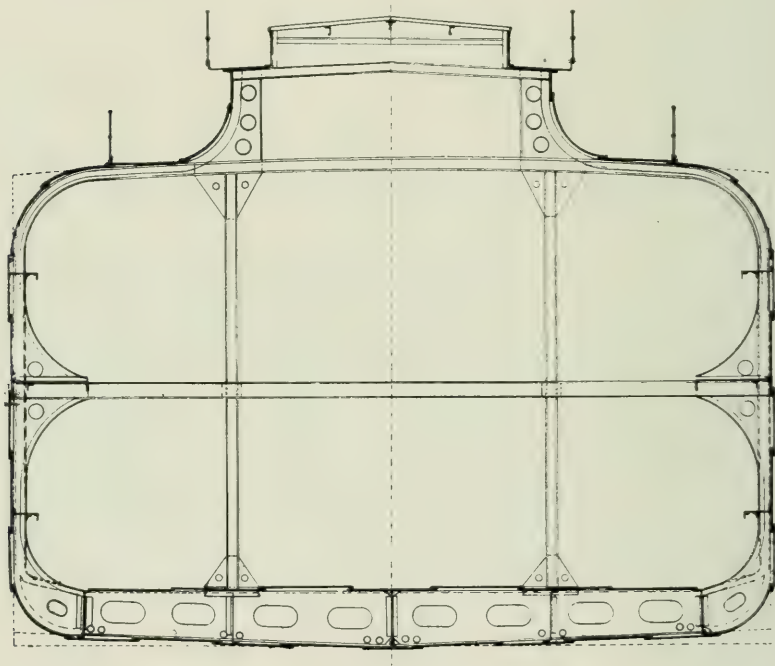


BUTE COAL-LOADING DOCKS, WITH LEWIS-HUNTER CRANES, CARDIFF.

Twenty-two ships, aggregating 121,000 tons, were in the harbour when the view was taken.

loading coal been proved to be 293 tons with one crane in an hour, but the coal is shipped in very much better condition owing to the construction of the carrying boxes, or hoppers, each holding 10 tons, the cone valve or bottom of which is only released to let the coal out when it is within 18 inches of the flooring, an advantage easily appreciated when dealing with a friable coal. Vessels carrying as much as 10,000 tons have been loaded by these cranes, and 7,000 tons have been put on board of them in the 24 hours. In the case of the steamship *Samoa* 7,484 tons of cargo and 1,750 tons of bunkers were put on board at the

average rate of 330 tons an hour, and in the present state of the labour market it is perhaps of sufficient interest to note that this 6,000-ton self-trimmer was loaded under these cranes without having to send a single "shovel" below for trimming purposes, thus saving considerable time. The Cardiff "trimming" rate, it may be mentioned, is $2\frac{3}{4}$ d. per ton for these ships, varies from 6d. to 1s. per ton for bunkers and difficult ships. There were eleven of these cranes at work in the Cardiff docks at the time of my visit. Another method for rapidly shipping coal is in use by the Cramlington Coal Company in the



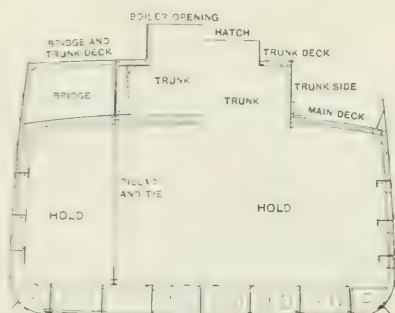
MIDSHIP SECTION OF A VESSEL OF THE TRUNK TYPE.

Northumberland Dock, on the Tyne. This is a belt-conveying system invented by Mr., now Sir, Thomas Wrightson.

With the advantages above stated in its favour, it need scarcely be said that the "self-trimmer," "trunk-deck," "turret-deck," or call them what you will, steamers (collectors of dues and other interested parties call them "cargo-cheaters") quickly came into favour with coal ship-

pers and each year they are being built in increasing numbers and size, and notably in the yards on the north-east coast.

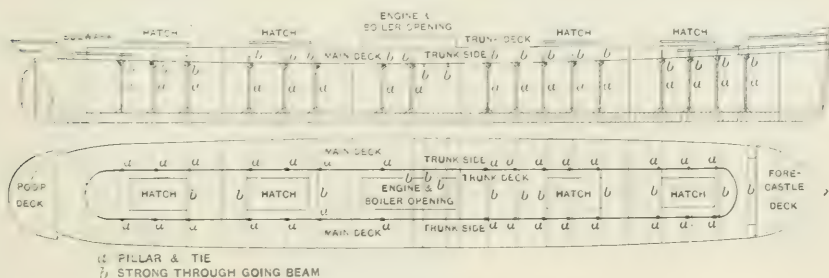
Before entering upon a description of the structural peculiarities of this type of ship, it may be noted that they are all good sea boats with increased stability. The self-trimmer, in addition to effecting a saving in trimming charges, also lends itself to a considerable reduction of net tonnage, hence the generic term "cargo-cheaters." These vessels are also well-adapted for carrying a large cargo on a small draft, and although they give clear hold spaces the shifting of the cargo is well-nigh impossible, a further point in their favour being that they are good timber carriers, both in hold and deck cargo. Regarded æsthetically, the self-trimmer certainly cannot be considered a thing of beauty, though as dividend earners they may prove a joy forever to their owners.



SECTION THROUGH A TRUNK-DECK STEAMER.

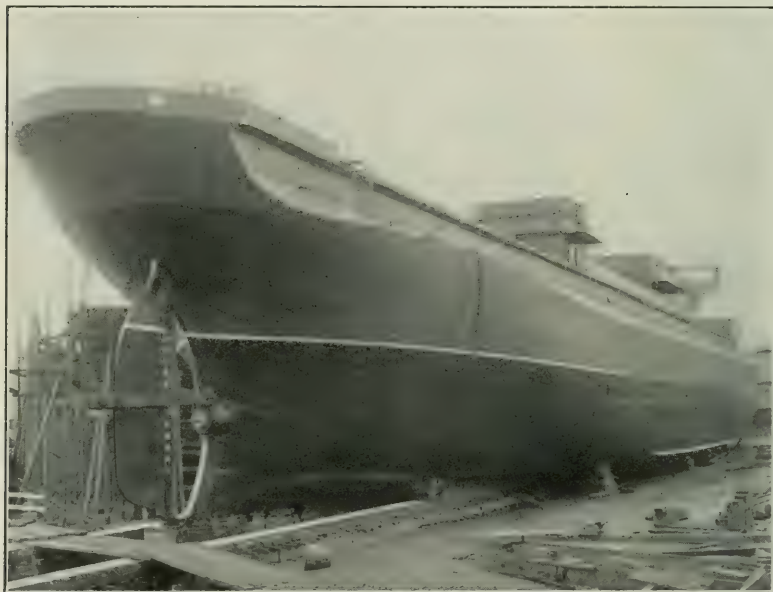
Briefly described, a self-trimmer may be said to be a vessel having erected on the midship portion of the upper deck two fore-and-aft vertical girders which extend for at least one-half of the vessel's length. These are sufficiently incorporated with the main structure of the vessel, as shown in the accompanying sectional drawings of the various types, and usually carry on the deck connecting the upper members of the girders all hatches, deck machinery, loading and discharging gear, pipes, ventilators, companions, and so forth.

For the mere sake of strength such a structure as the trunk need only extend one half the length of the vessel, but in order to obtain uniformity of the general arrangement throughout, the trunk is gener-



PROFILE OF A TRUNK-DECK STEAMER.

ally carried to the after-end of the forecastle and fore-end of the poop. It is not connected to these erections, however, but a passage way is left at each end to enable the crew to pass from one side of the main deck to the other without having to ascend to the trunk deck. By keeping the erections separate, better accommodation is permissible in the forecastle and poop; and the short wells that are thus formed prevent seas that find their way over the forecastle or the poop from travelling the whole length of the navigating platform, and imperilling the safety of hatch openings, deck machinery, deck pipes, officers, and



A DOXFORD TURRET SHIP A TYPE OF BULK CARGO CARRIER CLOSELY ALLIED TO THE TRUNK-TYPE VESSEL

crew. Any seas shipped descend from the forecastle or poop direct to the main deck, and return through the clearing ports at the sides into the sea without reaching the trunk deck at all. By this method of construction, every cargo hold in the vessel is provided with a trunk and is thus self trimming. The trunk also forms a navigating platform throughout the whole length of the vessel, beyond the reach of any seas, and a place of safety for all vulnerable parts on the deck. Short, narrow gangways are usually fitted between the trunk and the forecastle, and the trunk and the poop, so as to enable the crew to pass the whole length of the vessel without having to descend to the main deck.

It will be noticed from the profile of the trunk-deck steamer that the sheer of the top of the trunk differs from that of the main sheer,



THE FOREST BROOK. A TYPICAL SELF-TRIMMER.

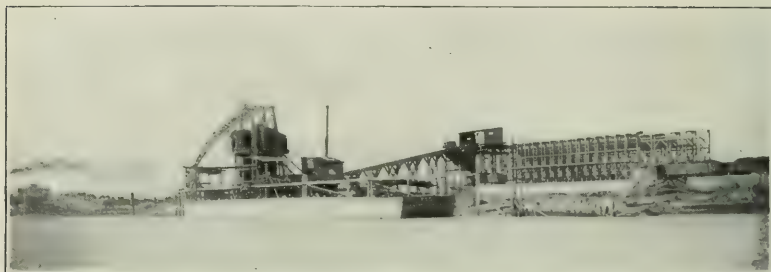
Midship section of this vessel is shown on page 160.

and is practically straight. This somewhat reduces the capacity in the end holds, resulting in less strains in the loaded vessel, but it increases the capacity in the trunk aft relatively to the forward trunk, which relative increase, though small, suffices to make vessels of this type trim by the stern, like the old raised-quarter-deck vessels, even when loaded



THE WHALEBACK. A SPECIAL TYPE OF VESSEL FOR BULK FREIGHT DEVELOPED ON THE AMERICAN GREAT LAKES.

The vessel shown is the Thomas Wilson, 308 x 38 feet, 1,713 gross tons.



B. D. WOOD'S COAL-LOADING WHARF, NEW ORLEANS, LA.

New Orleans is likely to attain prominence as a direct port for ocean shipment of coal brought wholly by water from the Pennsylvania fields. The plant was installed by the C. W. Hunt Company.

with homogeneous cargo, such as grain, with which the English outward coal-freighted vessel has frequently to return.

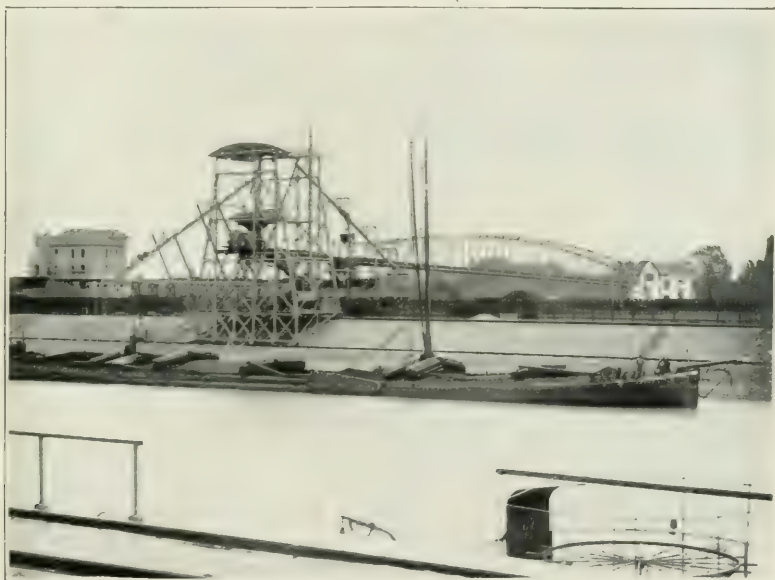
There are other advantages to which the trunk-deck type of vessel lends itself, and amongst these may be mentioned ventilation and ballasting. In many of the vessels constructed by Messrs. Ropner and Son, hollow stanchions, or pillars, are used with advantage to effect this purpose. These ventilator stanchions serve the double purpose of supports and ventilators, and their use has proved satisfactory in all the vessels in which they have been fitted. Many schemes for ballasting self-trimmers otherwise than by the ordinary double bottoms have been suggested, but so far none appear to have met with any great measure of success. I believe, however, that vessels have been fitted with the corner tank arrangement invented by Messrs. T. L. Livingston and J. Sanderson. And here, as an exception, I may state that some of the later self-trimmers have sheer, and therefore do not trim so well by the stern as the earlier and, if we may so call them, non-sheer vessels did. The tendency is to increase the size



DANISH COAL COMPANY'S WHARVES, COPENHAGEN.

C. W. Hunt Company's coal-loading appliances at the great free port which seeks control of the commerce of the Baltic.

and speed of all steamers nowadays, and the rule holds good in regard to self-trimmers. Many of them will carry 7,000 tons of coal as cargo at 11 knots, and there is sufficient evidence to support the view that the larger the vessel the more economical, in proportion, is the coal consumption. A return now before me, in which are given the results of a large number of voyages by different ships, shows that a 9,000-ton steamer, running 267 miles a day, had a consumption of .036 lb. of coal per ton displacement per mile. An 8,000-ton steamer, running 266 miles a day, used .038 lb., while a 7,000-ton vessel, steaming 264 miles a day, burned .048 lb. A 6,000-ton steamer, going 257 miles a day, used .054 lb. of coal per ton displacement, and a 5,000-ton



HUNT ELEVATOR AND AUTOMATIC RAILWAY, LUDWIGSHAFEN, THE GREAT INTERIOR GERMAN PORT AND CENTER OF COAL DISTRIBUTION FOR THAT PART OF EUROPE.

steamer, travelling 260 miles a day, .067 lb.; while a 4,000-ton steamer, going 269 miles a day, consumed .081 lb. These figures show in each case speeds of close about 11 knots, and they also show that the cost of the 9,000-ton steamer for coal was less than half that of the 4,000-ton boat, per mile per ton displacement, showing that the larger the steamer the less the coal consumption *pro rata*. In regard to this question of increasing the size of our ships, the same question was raised by Professor Biles at the last meeting, in London, of the Institution of Naval Architects, in his paper "On Large Cargo Steamers." The author of the paper, in dealing with the question of the effect of

increase of size upon working expenses, including coal, wages, etc., showed that these items were less per ton carried in the large than in the small steamer. Taking a steamer 500 feet long and 60 feet broad, with a draft of 27 feet 6 inches, he found that by increasing the length to 700 feet, with a proportionate increase in the breadth, but keeping the draft constant at 27 feet 6 inches, the cost of carrying a ton of cargo 5,000 knots, at a speed of 12 knots, increased from 8s. 6d. to over 11s. But if the draft, instead of being kept constant, was increased in proportion to the other dimensions, then the cost of carrying a ton of cargo 5,000 knots at 12 knots decreased from 8s. 6d. in

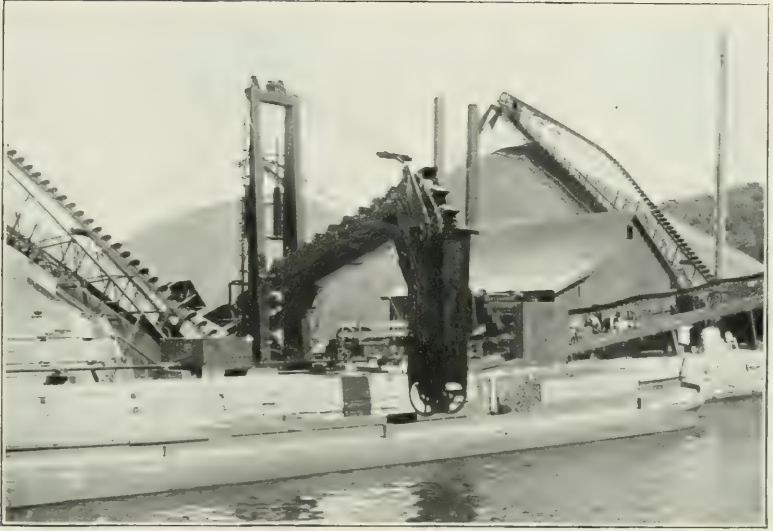


RAPID COAL-HANDLING PLANT FOR CAR DUMPING, T. & O. C. R.R., TOLEDO, OHIO.

Brown Hoisting & Conveying Machine Co.

the case of the 500-foot ship, to 7s. in the case of the 700-foot ship. The question of draft is, therefore, a very important factor to remember in the design of our modern mammoth cargo carriers.

In my opening sentences, reference was made to the first steam collier, the John Bowes, plying between the Tyne and London, and for purposes of comparison with the large ships of the present day her dimensions may not be here considered out of place. She was a three-masted iron screw steamer, schooner-rigged, and was built by Palmer Bros., Newcastle, in 1852, her length being 150 feet, breadth 25 feet 7 inches, and depth 15 feet 6 inches. Her net tonnage was 270 tons, and she was fitted with engines of 60 indicated horse power. This lit-



DOCK LEG ELEVATOR HANDLING COAL FROM BARGES TO WHARF STORAGE.
The machine is adjustable at both out-board and in-board ends, and has a capacity of 120 tons an hour. Link Belt Engineering Co., Philadelphia.



BRIDGE TRAMWAY MACHINES FOR COAL HANDLING, WHARVES OF L. S. & M. S. RAILWAY, ASHTABULA, OHIO.

Brown Hoisting & Conveying Machine Co.

the craft may be undoubtedly considered the forerunner of our present steam ocean colliers.

Though I have consistently advocated the self-trimming steamer as being most suitable for the duties of an ocean collier, I am not unmindful of the old saw that anything with a bottom to it will do to carry coal. But to the coal shipper, as to all other shippers, the question of speed—that is, economical speed—must ever be paramount, and I have said sufficient to show that the big trunk steamer moving at 11 or even 12 knots, is the vessel most suited to meet all the requirements of the coal trade.

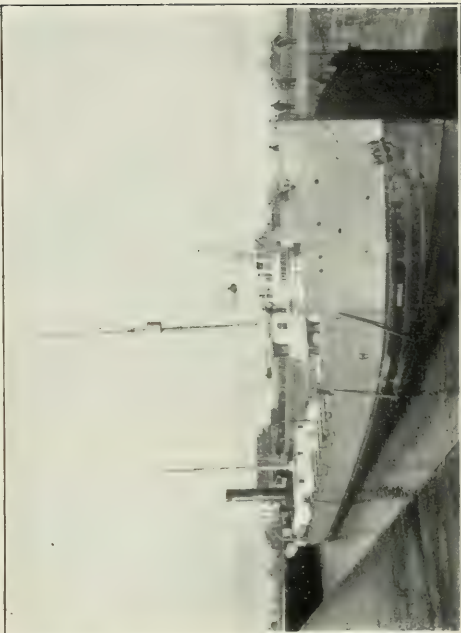
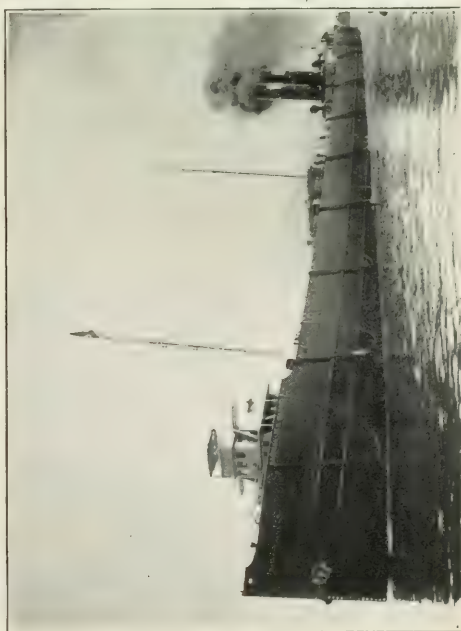
I stated in the opening that the overseas coal trade of the world last year might be taken at 62,500,000 tons, and it may be assumed that the



THE COAL CARRYING SCHOONER. THE TYPICAL COLLIER OF THE ATLANTIC COAST OF THE UNITED STATES.

The Cactus, shown in the engraving, is 149 x 34 feet, and of 534 gross tons.

present coal output of the whole world may be taken at 700,000,000 of tons a year. There is practically no limit to the possible increase of the supply of coal, and as the population of every country increases so will the need of coal increase. At present the demand for coal by the world's great industries is ahead of the supply: how long it will keep so remains to be seen. Certainly the period will be shortened, so far as Great Britain is concerned, if American coal can be imported at a sufficiently low price—in other words, when American ship-



TYPICAL COAL-CARRYING VESSELS ON THE AMERICAN GREAT LAKES.

The vessels on the left are the Sir William Siemens, 413 x 48 feet, 4,344 gross tons, and the Samuel F. B. Morse, 450 x 50 feet. On the right are the Lackawanna, 269 x 30 feet, 2,015 gross tons, and the Buffalo, 258 x 35 feet, 1,762 gross tons.



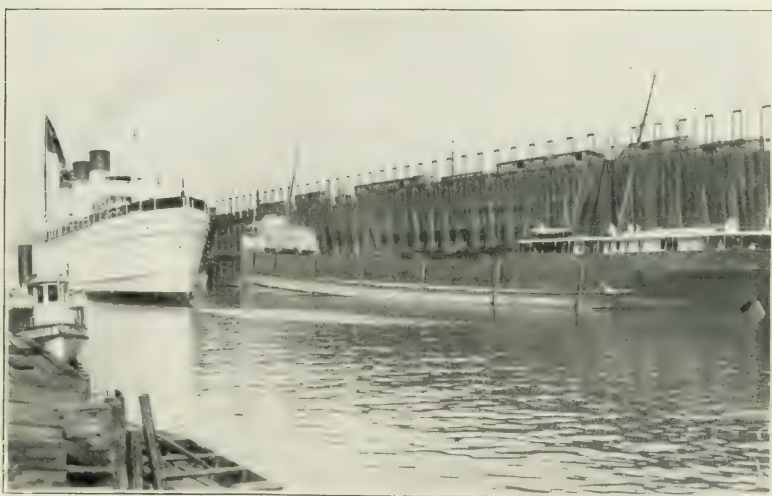
TYPICAL LAKE COLLIER—WHALEBACK, BARGE, AND STEAMER—AT COAL-LOADING PIER, BUFFALO, N. Y.

owners, or, failing them, coal owners themselves, find it worth their while to build ocean colliers on a sufficiently large scale. The average cost of coal per ton at the pit head in the United States is given on a computation based on the returns for 1896, as 4s. 9½d. per ton, as compared with 5s. 10½d. in the United Kingdom, 6s. 11d. in Germany, 7s. 7d. in Belgium, 8s. 8d. in France, 5s. 9d. in New South Wales, 10s. in New Zealand, and a fraction over 5s. in Japan. If therefore, American coal owners can scarcely yet hope to break, with any profit to themselves, the proverbial record of "sending coals to Newcastle" they have still other countries open to them. As competitors, British coal sellers are already beginning to feel more severely than may be pleasant the presence of American coal in markets in which English coal has hitherto been supreme. This may, of course, be only temporary, and is no doubt in great measure due to the war



COAL-HANDLING MACHINERY, MASSACHUSETTS WHARF COAL CO., EAST BOSTON, MASS.
By the C. W. Hunt Co.

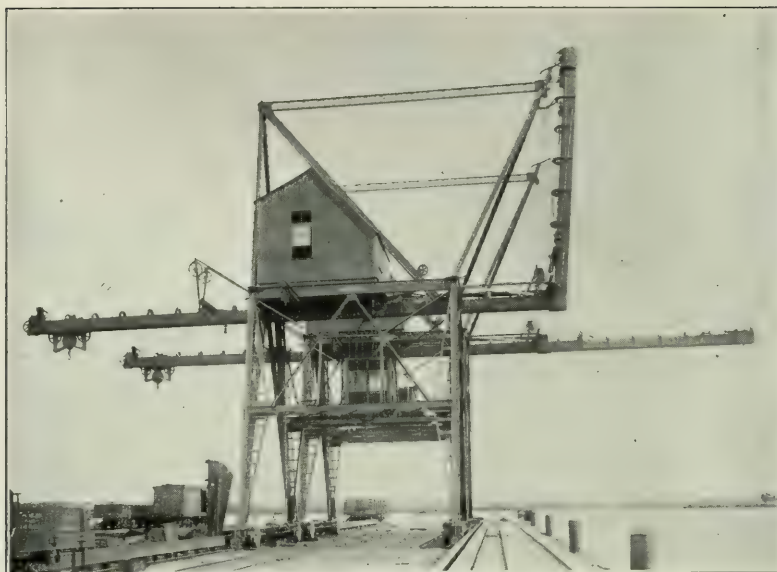
in South Africa, the advance in freights, the pressure on English coal-ing stations, and to the great advances in coal prices in Cardiff and Newcastle. But whether or not we regard the presence of American coal in domains that England formerly considered sacred to the home product as temporary, the fact remains that American coal is now being shipped to Barcelona, Marseilles, the Canaries, the River Plate, Rio de Janeiro, the West Indies, the Straits, and China, while quite recently a cargo of coal was shipped from Norfolk, Virginia, to Nagasaki. The striking feature of this last shipment lies in the fact that the



LAKE COLLIER AND PASSENGER STEAMER NORTH LAND COALING AT LACKAWANNA
COAL CHUTES, BUFFALO, N. Y.

celebrated Takashima mines lie at the entrance to Nagasaki harbour and the coal from these mines has hitherto been able to retain most of the coal trade in that part of the world. Though England did not supply the cargo (it amounted to 6,000 tons), it is at least some consolation to know that it was carried in a British ship, the *Needles*, a vessel of 2,995 tons net.

Having found the markets for their coals, it is but reasonable to expect that American capital and enterprise will soon provide the ships to carry them in, and we shall expect to see many a self-trimmer flying the Stars and Stripes in the near future. Nor can we, after a careful review of the coal resources of the United States, of the exceptional ease and cheapness with which they can be mined, and of the readiness with which the very best coal in the States can be brought to the seaboard, but admit that America will, in the near future, be Eng-



"FAST-PLANT" MACHINE FOR COAL HANDLING, PORT RICHMOND COAL WHARVES,
P. & R. RAILWAY, PHILADELPHIA.

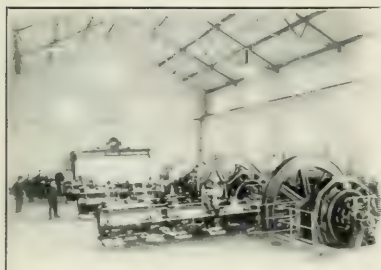
Each of the two machines is operated electrically from the small house. Brown Hoisting & Conveying Machine Co.

land's most active competitor in the coal trade of the world, and, next to the English, the largest owners of specially-designed and economically operated ocean colliers.



THE DEVELOPMENT OF ELECTRIC RAILWAYS IN ITALY.

By Enrico Bignami.



AS compared with the cost of steam power, the relatively small cost of water power in Italy—especially in the northern portion, where it is abundant—has contributed no little to the application of electricity for traction purposes. This, however, does not imply that all trac-

tion plants in Italy are worked by water power; many of them are operated by steam, and among them some that have shown excellent financial returns.

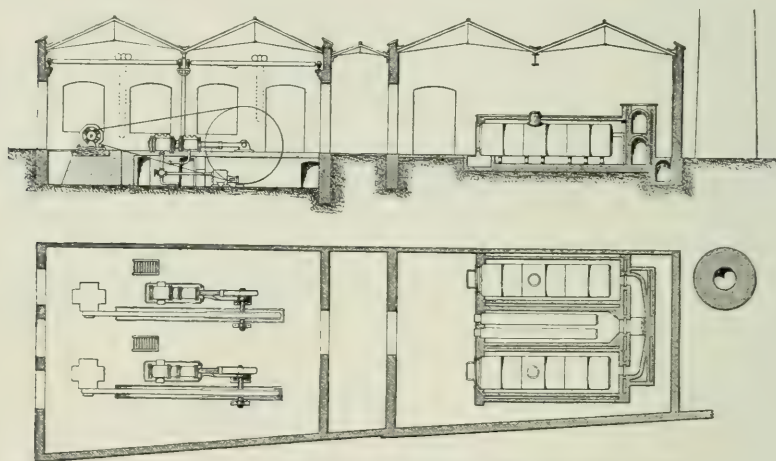
In point of time, the first electric tramway in Italy was that between Florence and Fiesole, upon which service was begun now nearly ten years ago, in September, 1890; it was originally built with Sprague apparatus, now partly superseded by Thomson-Houston equipment. At that time there were no builders of electric-railway equipment in Italy, on which account the "Compagnie Thomson-Houston de la Méditerranée" undertook to establish, then and there, a large branch office in Milan. There soon appeared in Italy, especially at Milan, Savigliano, and Turin, excellent constructing firms.

The Florence-Fiesole line, with one branch, was 4.53 miles long and of standard gauge of 1.435 metres (4 ft. 9 $\frac{1}{4}$ ins.), with Vignole rails of 50-pound section. Its maximum grade was 8 per cent., and its curves were of 59-feet minimum radius. The power plant was furnished with two steam engines of 92 horse-power each, and the conducting system was the overhead trolley, working at 500 volts. There were ten motor cars, each seating 24 passengers, with an equipment of 15 horse-power Thomson-Houston motors.

From the time of the opening of this road to traffic two years elapsed before another was constructed—the line running between the Piazza Corvetto and the Piazza Manin in Genoa, which was built in 1892, with Siemens-Halske equipment and 50-pound Vignole rails. The station was operated by two 110 horse-power engines driving two

Siemens internal-pole dynamos. The line equipment was overhead, working at 525 volts, and there were four motor cars, each equipped with two 13.5 horse-power Siemens motors.

The third line built was an experimental system, between the Piazza del Duomo and the Porta Sempione, in Milan, finished in 1893 and equipped with the Thomson-Houston system. It was extended in 1895 to the Cimiterio Monumentale and finally as far as the new Cimiterio di Musocco.



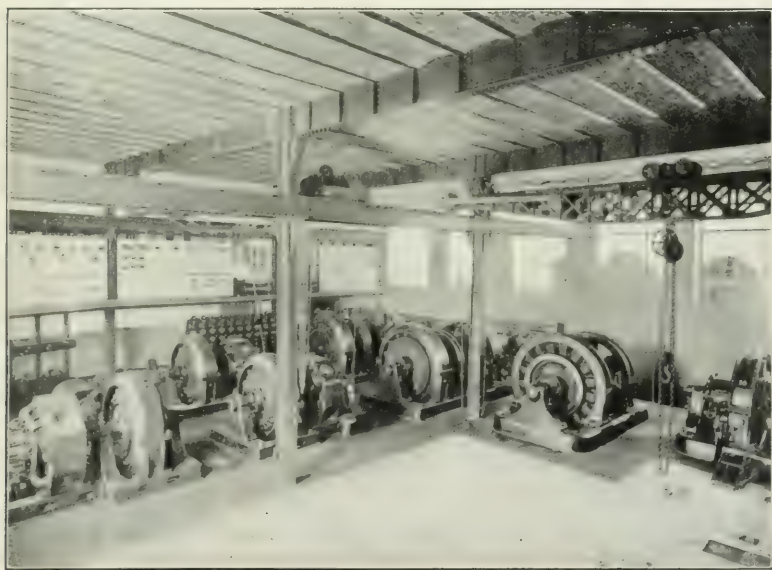
PLAN AND ELEVATION, MUSOCCO GENERATING STATION, MILAN.

The Società Generale Italiana Edison obtained a concession to build a tramway between the two cemeteries on condition that it should furnish suitable vehicles for the conveyance of the dead. For this purpose its trains are of three cars, one being a funeral car or hearse, draped in black, and the other two, intended for the friends and family of the deceased, are arranged with seats like ordinary street-cars, but are upholstered in black and blue and decorated with the arms of the city of Milan. On this line there are five motor cars, weighing 13,640 pounds each, carrying each a single 25 horse-power motor. There are three trail cars, weighing 5,720 pounds each, and four hearse cars, weighing 11,440 pounds each, these comprising the entire rolling stock of the road.

So encouraging was the experience of these two lines that it decided the municipality of Milan to enter into contract with the Società Generale Italiana Edison for the changing over of all its horse-car lines to electrical traction. At present there are, in Milan and its suburbs, 60.7 miles electrically-equipped track, with 210 motor cars and about 20 trailers in operation.

The company has three car-barns, with a capacity of 450 cars. At the end of 1899 it owned 250 cars, of which 30 were trailers and 3 sweepers, all made in Milan. The power comes from the waterfalls at Paderno d'Adda, 13 miles away, being transmitted over a three-phase line at 13,500 volts. The plant is of great general interest, its total developed energy being distributed for lighting, traction, and many and varied small industries. At the outskirts of the city the pressure on the transmission line, for the street-railway current, is transformed down to 3,600 volts, at which it is distributed to the center of the city and utilised in synchronous motor-generators, giving 550-volt direct current. The distributing network is divided into four sections supplied by twelve feeders.

In 1895 three other cities—Genoa, Rome and Varese—followed the example set by Milan. At Genoa, as was mentioned above, there was started, towards the end of 1893, a little road about half-a-mile long, but it was not until the end of 1895 that the transformation of



NEW CONVERTING STATION OF ST. RADEGONDA, MILAN, FOR CONTINUOUS-CURRENT LIGHTING AND TRACTION SERVICE.

the Gencese tramways was undertaken in a thorough-going manner. The numerous difficulties caused by the hilly conformation of Genoa obliged the Allgemeine Elektrizitäts Gesellschaft, of Berlin, which firm undertook the construction, to bring out much interesting work on the line. All the cars were built in Milan.

Three companies operate various portions of the Milan lines: the Società di Ferrovie Elettriche e Funicolari works the lines inside the city, while the Società dei Tramways Orientali operates those on the east and the Unione Italiana Tramways Elettrici those on the west. Actually the three concerns work together according to a uniform schedule, running cars on 16 lines with a total length of 71.3 miles.

Some lines have a considerable length, for example, the Voltri-Nervi line, which is 18.6 miles long. Some have grades ranging from 4 to 8 per cent. and having sharp curves in places. In certain points it was necessary to make use of a cable system, of which there is a total length of 0.87 mile, with a maximum grade of 24 per cent. In other points considerable engineering works were necessary, as in the boring of special tunnels of relatively considerable lengths and in part underlying houses of the better class, and the grading of streets and squares. A highly interesting tunnel is that under the hill of St. Ugo, which is a spiral of from 22 to 38 yards radius, with a difference of level of 13.2 yards between the spires.

Of the 71.5 miles of track 3.75 miles are in tunnels, 1 mile cable, and 5.4 miles cable railway in tunnels. There are four grip cars, four large car barns, five small car barns and two power-houses, of 1,000 horse-power and 7,000 horse-power respectively, the latter being used also for electric lighting.



PORTA VOLTA CAR SHEDS, MILAN.



USUAL TYPE OF MOTOR CAR AND TRAILER, MILAN TRAMWAYS.

The first electric tramway in Rome was started in 1895, the experimental road built previous to this time by Captain M. Cattori being hardly worth consideration as a serious effort. The first of the Roman lines running between the Piazza S. Silvestro and the Piazza Venezia was installed by the Società Romana Tramways Omnibus with Thomson-Houston apparatus, and was thrown open to the public on Sept. 19, 1895.

The system was a highly interesting one, in as much as it combined at the same time a water-supply system, high-tension alternating-current supply, continuous-current supply at moderate pressure, accumulators, and the trolley system. The power station is at the waterworks at Tivoli, about 18 miles from the city. The electrical energy is here generated at a tension of 5,000 volts, alternating, and reaches Rome at about 4,000 volts. Here the pressure is reduced to 2,000 volts for distribution, and some of it is also converted into direct current at 550 volts by means of three 80-kilowatt rotary converters. A large battery of Tudor accumulators, connected in parallel with the rotaries, serves, in a way, as a flywheel for the system and provides an emergency supply of current. For two or three hours at night the railway system is fed directly by these batteries. One of the lines was operated as an experiment, with accumulator cars. The batteries used were of the light Pescetto type, and experience showed, technically

speaking, good results, but economical reasons dictated the abandonment of these cars in favour of the overhead-trolley system.

The system comprises 5,600 feet of double track, on which the grades are as heavy as 8 per cent. The curves have radii of 65 to 78 feet. The rails are of the Phoenix system, weighing 70 pounds per yard, the gauge being standard. The rail joints are bonded with two "Chicago" rail-bonds. At every 50 meters the two rails of the track are connected with a 7-millimeter copper wire, and at every 100 meters the four rails of the double track line are similarly connected. This system gives complete security against bad return connections.

The first outfit of cars comprised 14, each seating 22 passengers inside and 8 outside. To this equipment was quickly added that of eight other lines, with a total length of 28.17 kilometers (17 miles), all operated by the Società Romana.

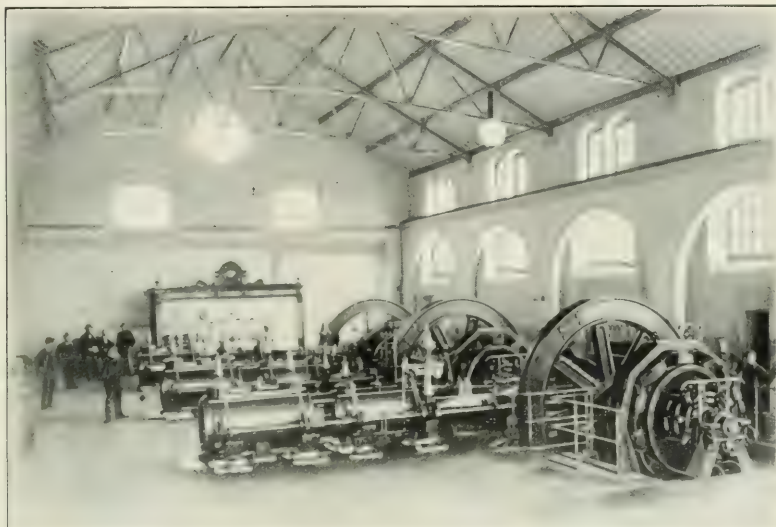


PIAZZA DEL DUOMO, A CENTER OF TRAMWAY LINES, MILAN.

The first electric railway at Varese was inaugurated in 1895, running from the railway station to the first chapel of the Sacro Monte—a road frequented by numerous pilgrimages—the distance being $3\frac{1}{2}$ miles, with heavy grade. The track is of one-meter gauge, and upon it are operated four motor cars and four trail cars. The power house contains two Tosi 66-horse-power engines and a battery of Tudor accumulators. Here also begins an interurban line, connecting Varese and Luino.

From that time on the principal cities of Italy began gradually to transform their tramway systems into electric railways. Turin, Florence, Leghorn, Naples and Palermo followed the example of Milan, Genoa and Rome.

The principal lines in Turin were inaugurated, on the occasion of the Electrical Exposition of 1898, by the *Società Torinese Trams e Ferrovie Economiche*, using Schückert* apparatus on 19.106 kilo-



ENGINE AND DYNAMO ROOM, LEGHORN GENERATING STATION.

meters (11.84 miles) of track, and by the *Società Anonima di Elettività Alta Italia*, using Siemens & Halske apparatus on 8.68 miles of track, to these being added in 1899 other lines, partly urban and partly interurban, of a total length of 17.061 kilometers, so that the beginning of this year found a total of 50.284 kilometers (31.18 miles) of electric tracks in Turin.

The plant of the *Alta Italia* company is of great interest, since it comprises a five-wire direct-current distribution for lighting in parallel with the trolley system, and a mixed traction system, using both trolleys and accumulators. The generating system is, in part, outside

* The Schückert concern, of Nuremberg (*Aktien Elektrizitäts Gesellschaft*, vormal *Schückert & Co.*), has established the following Italian sub-companies: *Società Nazionale*, of Milan, capital 5,000,000 lire; *La Società Lombarda per la Distribuzione di Forza*, of Milan, capital, 8,000,000 lire; *The Società Toscana*, of Florence, capital, 2,000,000 lire; *The Società Torinese dei Trams e Ferrovie Economiche*, of Turin, capital, 4,500,000 lire; *The Società Siciliana dei Trams e Omnibus di Palermo*, of Palermo, capital, 1,000,000 lire. The Central Company of Palermo, with a capital of 2,500,000 lire constructed a part of the Turin traction system and has a contract for that of Bergamo. The lira is equal to the franc—substantially 19 cents or 9½d.

of the city. Direct current at 550 volts is generated by three Siemens internal-pole, 600-kilowatt generators, direct-coupled to Tosi engines. The motor-generators in the station are operated by current coming from Lanzo, 19.8 miles away.

The cars are fitted with Siemens bow trolleys and accumulators also. In the central part of the city the trolley is tied down, and the car is operated on the batteries alone. No change of electrical connection is involved in passing from one system to the other. At present forty motor cars, with twenty trailers, are in use. Each motor car



ALONG THE HARBOUR, LEGHORN.

is equipped with two motors, seats 40 persons, and weighs, complete with its battery, 14 tons (metric).

The Società Torinese equipment is entirely overhead, the company having paid to the municipality 1,000,000 lire for permission to abandon the mixed system. When the Alta Italia company made application for permission to abandon the mixed system in favour of the trolley, the communal council of Turin unanimously approved an ordinance requiring the company to pay a fixed tax of 2 centesimi per car-kilometer, for both trailer cars and motor cars, the profits of the undertaking to be equally divided between the company and the municipality. Under these circumstances the present concession was preferred, and has been extended for ten years.

The equipment of this system (Società Torinese) is very like that

in use in the United States. The power plant has multitubular boilers furnishing steam to three Tosi compound engines direct-coupled to Schückert dynamos of 500 horse-power each.

Among the Turin systems should also be mentioned a section of experimental line built by Sig. Alfredo Diatto between the shops of Messrs. Tedeschi & Co. and the Lanza gate. This surface-contact system was first adopted for the Tours tramway and afterwards for about 50 miles of line in Paris.

Another Italian inventor, a priest, Monsignor Luigi Cerobotani, has recently contracted with a Veronese establishment for the construction of a trial system of electric trams. The conductors used are simple insulated-copper wires running along under the track. The rails, which are used for picking up the current, are not continuous,



LEGHORN, SHOWING ELECTRIC RAILWAY LINE IN THE FOREGROUND.

but are divided into sections, insulated from one another, so that the track may be considered as forming many pairs of current-carrying pieces. Each rail of each pair can be connected with one of the copper conductors by means of a lever switch, which is closed by the passage of the car. For this purpose the car is furnished with two iron bars magnetised by electro magnets operated by the propelling current.

At Florence the inauguration of the first Florence-Fiesole line waited eight years after the line from the Piazza del Duomo to the Viali di Circonvallazione (3.8 miles) was completed, but the latter

was soon followed by other lines, so that at the first of this year the Florentine system, all operated by the Société des Tramways Florentins, had a total extension of 25.75 miles. The lines comprise three principal systems, radiating from the Piazza del Duomo, the center of the city, to the suburbs, and subdividing into seven lines. A belt line built along the fortifications completes the system.

The power house is rectangular in form and is located on the belt line at the point where the Fiesole line crosses it. In the boiler room is a battery of four boiler units, of the Weinlig system, having superposed cylinders. Each boiler can give from 2,500 to 3,000 kilograms of dry steam per hour at a pressure of 125 pounds. Each boiler carries a steam-trap, of the Schwörer system, furnished with a safety-valve. A Green economiser is interposed between the boilers and the chimney, which is 186 feet high. Feed water, after passing through a Desrumeaux purifier, is received in a reservoir, and thence pumped, by means of two feed-pumps, through the economiser to the boilers. The engine room is equipped with three horizontal compound engines of the tandem type, adapted to exhaust either to a condenser or into the open air. The generators are direct-coupled to the engine. Two of the units are of 700 nominal horse-power, each at a speed of 120 revolutions per minute and with a steam pressure of 120 pounds and a vacuum of 26 inches. The third unit runs at the same speed, but is of only 350 horse-power. The two large engines are each coupled to an 8-pole, 425 kilowatt Thomson-Houston generator, giving 500 to 550 volts. The smaller engine drives a 6-pole, 225-kilowatt machine of the same type.

The supply feeders for the system are laid underground in the central part of the city, and consist of two strongly insulated and armoured cables 500 and 250 square millimeters in section, connected in with the trolley line at the junction points through switches. In the suburbs all the feeders are overhead, consisting of bare copper cables of 250 or of 125 square-millimeter section. The rails are connected by means of two "Chicago" rail-bonds 9 millimeters in diameter at each joint, and the rails are cross-connected at every 50 meters by a tinned copper wire of the same diameter. Return feeders are made of old rails of 60-pound section, well connected together, and buried about 30 inches below the tracks.

The rails used in the city are of the Broca type, having a 65-pound section and made in 32.8-foot lengths, while the suburban sections are laid with 50-pound T-rails. Seventy-five motor cars are in use, of which sixty are closed cars, each equipped with two General Electric

25-horse-power motors, ten are open cars, with two similar motors, and five are closed cars, with two 50-horse-power motors on each. The latter cars are used to haul in and out of the city trains from external lines using steam locomotives outside the fortifications. A considerable number of trail cars are also in use. All the motor cars have electric brakes.

At Leghorn the Società Anonima delle Tramvie Livornesi threw open to the public on October 14, 1899, its first line through San Marco Antignano, 4.8 miles long. The track is of standard gauge. Two engines of 50 horse-power each furnish power for three motor



A FLORENTINE ELECTRIC TRAMWAY.

cars. At the end of 1899 the track had been extended to 6.92 miles.

At Naples, since the first trolley line was completed, in January, 1898, by the Società Anonima dei Tramways Napoletani, with 3.5 miles of track, four others have been constructed, with a total of 8.35 miles. To these will very soon be connected a line through Sorrento to Castellamare di Stabia.

At Palermo there are now three lines—those of Piazza Bologna to Rocca, of Piazza Indipendenza to Romagnolo, and that of Palermo to Monreale, with a total length of 9.67 miles.

The example set by the larger cities was followed in the smaller ones; Nervi has a line to Rocca; Perugia has a one-meter gauge line 2.65 miles long; there is a line from Prato to Rocca, and Bergamo has

a line a mile long from the railway station to the foot of the cable road. Between Milan and Monza, on the track of the Mediterranean railroad, an experiment has been in progress with accumulator cars.

For some time there have been electric tramways at Como, at Catania, Spezia and Brescia, using "Helios" apparatus, which is also being used in lines under construction near Genoa and Florence, and also lines between Milan and Affori and Milan and Corsico.

At Como the Helios company had already installed and operated a line from the railway station to the Piazza del Lago during the exposition of 1899. Now it is negotiating for taking up the line again and extending it to Camerlata, 3.2 miles, and to Chiasso and Cernobbio, 7.45 miles.



ELECTRIC CAR, PERUGIA, SHOWING SLIDING CONNECTIONS.

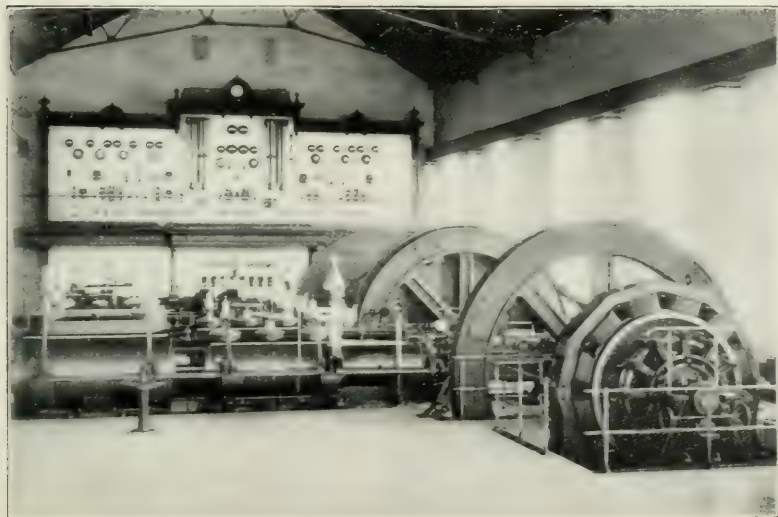
The Catania concession was held by Singer & Co., of Berlin, and the construction work was done by the Helios Company, of Cologne. The total length of the lines is 19.8 miles, of which half is in the city and half in the suburbs. The system is the familiar trolley, with 500 volts' pressure. The power plant also furnishes current for lighting, and absorbs about 400 horse-power. There will be installed four dynamos of 500 kilowatts, giving three-phase current at 3,000 or 4,000 volts. For the railway the current will be transformed and changed to direct current by rotaries working in two sub-stations, one in the city and the other in the suburbs. Steam power will be used exclusively, and the power plant will be near the sea, a maximum distance of about



CENTRAL STATION, PALERMO.

4.35 miles from the point of application of the power. In the city cars on single trucks and carrying thirty passengers will be used, while the suburban service will be performed by double-truck cars seating forty. Work on the system is going ahead now and will be completed in two years at a cost of about four or five million lire.

The plant at Spezia is now under construction by the Società



DYNAMO ROOM PALERMO GENERATING STATION.



ROCCA-MONREALE LINE, PALERMO.

Italiana Industrie Elettriche. The finished track will be about 12.4 miles long, of standard gauge. The overhead system, with bow trolleys, will be used. Two 250 horse-power Tosi engines will drive two Helios dynamos and boosters, which will be used in connection with a battery of accumulators. It is thought the line will be open in the autumn of 1900.

To sum up, there were, on December 31, 1899, 244.5 kilometers (153.6 miles) of electric tramways, nearly all of standard gauge, in Italy. Of them the greater part operate on the trolley system, using Thomson-Houston, Siemens & Halske, Schücker & Co., and Helios equipment.

Of mechanical-traction systems in use in the Kingdom of Italy at the beginning of this year, there was, according to a report of the Ministry of Public Works, a total length of 3,179.5 kilometers (1,971.3 miles), of which only eight per cent. was electrical. More than 600 miles of these urban and interurban lines are now in course of transformation to electric systems. In this way are projected—and in part the concessions have lately been obtained—electric railways between Alessandria and Valenza, between Cuneo and Pesio, between Vercelli and Crescentino, between Padua and Vicenza, Como and Segre, Bergamo and Treviglio, Reggio d'Emilia and Castelnuovo dei Monti, Ferrara and Pontelagoscuro, Castel Raimondo and Camerino,

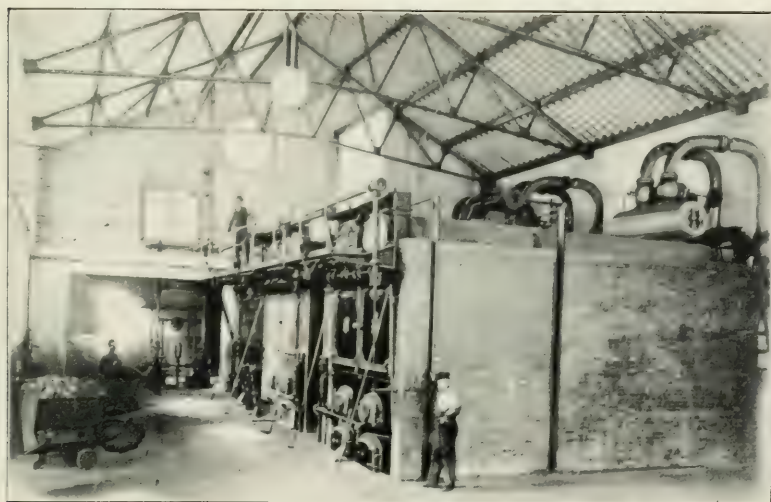
Rome and Ostia, Cassino and Sora, etc., and all of these are understood to have sufficient capital (which finds a certain remunerative investment in such enterprises), and will be completed in a short time. The new lines will restore the status of many old lines and render profitable the transformation or construction of many new ones.

Geographically speaking, the cities of Trieste, Fiume, Lugano, Mentone, and Nice belong to Italy, and it will not be out of place to mention briefly the electric tramways installed in them.

There is no line in Trieste now, but one will soon be put in by the Union Elektricitäts Gesellschaft, of Berlin. This installation presents no unusual features. The tramways at Fiume are under construction by the same company.

Lugano was the scene of the first experiment in polyphase electric traction in Europe. A 75-kilowatt, three-phase alternator is used, working at 5,000 volts, and feeding, through transformers, lines at 400 volts in the town. There are three lines, 2.8 miles long in all, having four motor cars. The power is generated by a waterfall at Maroggia, 7.4 miles from Lugano.

Nice has had, for several months, a system of electric lines that will be extended through the Riviera so as to embrace, finally, about 93 miles of tracks. The system of Nice proper comprises the old horse-car line and new lines built since the transformation. On this system mixed traction is still in use in the central part of the town. In the streets through which the carnival procession passes conduits



BOILER ROOM OF THE LEGHORN GENERATING STATION.

of the open-slot kind are used, while in the outlying districts all the lines use the trolley.

The Littoral lines, which are about 31 miles long, include: 1. A line from Cannes to Mentone; 2. A branch line which runs to Nice, Piazza Garibaldi, and to the village of Cantes-les-Pins; 3. A system of lines in the city of Mentone. From that place a line runs to Ventimiglia, and further to Bordighera, as described above.



TRAMCAR, PALERMO-MONREALE LINE.

In addition to all these lines of local interest, there are the main-line railways. A vast field of operations is henceforward open in Italy for the application of electric traction on railways. Great ease in developing water power, united with a scarcity—not to say an absolute deficiency—of coal, has led the great railway companies to study the question seriously. Nothing seems to stand in the way of operating nearly all of their lines by means of electricity. Perhaps, with the actual present scientific and industrial development, it may not always be feasible, but it is certain that many lines would gain in economy of operation by substituting electric traction for steam.

The government commission appointed to study the question of electrical operation of railroads has concluded that it cannot be solved without experiment upon the following systems:

1. Cars with accumulators of the Planté type.
2. Cars with accumulators of the Pescetto type.
3. Overhead three-phase high-tension system.
4. Third-rail system with direct current.

Experiments with Planté accumulators are being made on the Milan-Monza line by the Mediterranean company. The Adriatic company proposes to undertake experiments with the Pescetto system on the Bologna-San Felice line. The same company will put the overhead system to test on the Lecco-Colico-Sondrio and Colico-Chiavenna lines. These will be most complete experiments on the transportation of goods and passengers under service conditions, and along with them will be made an attempt to supply electrical energy for industrial uses. The Mediterranean company will experiment definitely with the third-rail system on the Milan-Gallarate-Porto Ceresio line.

From experiments lasting more than a year on the 9-mile long Milan-Monza line, with cars equipped with Planté accumulators, running on the Mediterranean company's tracks at a speed of 26 miles an hour, the following data have been obtained: The weight of the car, which carries 100 passengers, is, without the live load, 127,600 pounds, approximate, distributed as follows:

	Pounds.
Car proper.....	74,800
Motors, controllers, cylinders and accessory compressor for Westinghouse air brake.....	11,000
Battery of accumulators for traction.....	39,600
Battery of accumulators for lighting.....	1,100

The weight of each element of the traction battery is 241 pounds, the total weight of plates in the 130 elements being 30,000 pounds. The remainder of the battery weight is due to the heavy lead connectors, the cells, and the electrolyte. The mean discharge current on the Milan-Monza run is from 230 to 250 amperes, and for over a third of the distance the battery is not used at all. The battery is charged up to 275 to 280 volts on open circuit, and makes one round trip on a single charge, its open-circuit tension falling to 260 volts at the end of the run, or 2 volts per cell. The two motors on the car were made by the Schücker company, the accumulators and cells by the Henssemberger firm of Monza, and the cars were built by Messrs. Crondona, Comi & Co., of Milan. The technical results of the test have been highly satisfactory, but there is room for improvement in the economical showing.

The Bologna-San Felice line, which has just started, for passenger

service only, with accumulator cars of the Pescetto type, is 26 miles long, with four intermediate stations. Three cars from the Diatto shops, in Turin, equipped with motors by Ganz & Co., of Budapest, comprise its equipment. The charging station is in the railway station at Bologna. It receives polyphase current at 3,000 volts and transforms and converts it to direct current at 500 to 750 volts through the medium of two motor-generators of about 100 horse-power each.

The Secco-Colico-Sondrio line, upon which the high-tension three-phase system using an overhead trolley, will be installed, is 65 miles long, and may well claim to be the first example in Europe of an important main-line electric railway. The motive power under development for it is about 7,400 horse power, and may be increased as the demands of passenger or goods traffic may necessitate. Power is derived from a waterfall near Morbegno, 9.4 miles distant from Colico and 15.5 miles from Sondrio. The head race for carrying 25 cubic meters of water per second, with a fall of 30 meters, will be 2.8 miles long, of which a little more than half is tunnels, the remainder being open cutting. Four units of water-wheels and dynamos will be installed in the power-house, each of about 2,000 horse-power capacity, generating current directly at 20,000 volts. These generators and the distributing switchboard will be furnished by Schücker & Co., while Ganz & Co. will construct the other parts of the electrical equipment, including the line and rolling stock. A contract has been let to the Società Italiana per la Trazione Elettrica sulle Ferrovie for the work, and this company will also operate the road for some years.

This is the first application of so high a tension to traction work with us, and the experiment is awaited with the utmost interest. A pressure of 20,000 volts will be fed directly to the overhead conductors. Every 10 km. (6.2 miles) a transformer station will be established, reducing the pressure to 3,000 volts, which will be the service pressure. Two of the conductors of the three-phase currents will be overhead, the rails forming the third. The method of insulating the trolley line under this high tension, as well as all parts of the electrical equipment, presents a number of novelties of design well worthy of attention. Trains will be light and will be run at short headways. The passenger and freight services will be entirely distinct from one another. Passenger cars will be provided with their own motors. Each car is on two four-wheel trucks, and every car carries four motors. Of these only two work normally, the other two being used on up grades. Schedule speed will be 60 km. (37.2 miles) an hour on the level and about half this on grades. All regulation is accomplished in the rotor

circuits of the motors, their stators being connected directly with the 3,000-volt line and no intermediate apparatus being included in this circuit in order to avoid the danger of accidental contact with the high-tension wires. The motors are mounted directly on the axles to reduce shocks and oscillations as much as possible. The highly ingenious system of block control adopted is such that if its signals are turned to "stop," or the switches are wrong, the line current is cut off. All chance of collision is thus eliminated. As a further safeguard, the stoppage of the line current sets powerful brakes on the train, so that if it enters a block improperly it is at once stopped.

Concerning the Milan-Gallarate-Varese-Porto Ceresio third-rail work, it may be said that the total system will be about 62 miles long and is composed of a standard double-track road from Milan to Gallarate, whence branch out three lines which, running through the lake regions of upper Italy, terminate respectively at Arona, Laveno and Porto Ceresio. The work will be undertaken by the Compagnia Thomson-Houston. High-tension three-phase currents will feed the sub-stations, where it will be transformed and converted to 600-volt direct current and at this pressure fed to a third rail. The rolling stock will comprise 20 8-wheel motor cars, each carrying a single 600 horse-power motor connected with an axle by a single-reduction spur gear. On account of these powerful motors a speed of 90 km. (56 miles) an hour will be attained, even when a train of several cars is attached.

Besides these lines, the railway from Sampierdarena to Ronco, which goes through the two Giovi tunnels, will use electric traction to avoid foul air in the tunnels and difficulties due to heavy grades. With the new system, by subdividing the tracks into short blocks, several trains may go up the grade at once. With steam traction to-day the maximum is 40 goods trains and 15 passenger trains a day, but with electric traction 95 freight trains of 20 cars each and a large number of passenger trains can ascend the Giovi grade daily in perfect security. At Sampierdarena a steam-power generating station will supply high-tension three-phase current to sub-stations at Mignago and Ronco, where the usual equipment of transformers and rotaries will reduce it to 700-volt direct current for the working conductors. Twenty-three electric locomotives of 40 tons and 544 horse power each for freight trains and 840 horse power each for passenger trains, will take care of the service referred to above. The plant as outlined will be sufficient for the needs of the port of Genoa for several years, which will give time to survey and execute another Transapennine artery of commerce.

PIECE WORK AS AN AGENCY IN MACHINE-SHOP COST REDUCTION.

By M. Cokely.

QUESTIONS affecting the relationship between employer and employee are of intense interest—particularly so to those whose duty it is to harmonize their conflicting views. Of these questions the greatest is that of remuneration, its extent and method. From the fact that the aim of the world at large is to get all it can, we would naturally suppose that extent would be the only view to consider; this is not the case, however, as labor unions, particularly in the metal trades, seek to subordinate extent to method—that is, they refuse to allow their members to receive a large wage if it is earned by piece work. This is particularly true of the machinists.

As piece work is purely a merit system, tending to excite ambition in a workman, it is consequently productive of a large day's work. Leaving envy out of consideration, the only reason we can ascribe for the workmen's hostility is the influence of that universal law of human nature, to do as little as possible for the highest wages obtainable. Through ignorance not only of the law of supply and demand—of trade and commerce—but of the very fundamental principles of manufacturing, they fail to realize that there must be a limit to the observance of this natural law—that the full realization of their natural desires is not to be accomplished in a lifetime, but will be the result of an evolutionary process requiring perhaps centuries to develop.

Human impatience, like all other explosive forces, when properly controlled is a most influential agent in bettering the condition of the human race; but it must not be allowed to burst its bounds, as it is then productive of excesses which we know are detrimental, and which must be compensated for by a swing of the pendulum in the opposite direction. We saw an instance of this in the great engineers' strike of a few years ago in England, when the rules of labor organi-

Mr. Cokely's point of view in regarding the piece-work system is a peculiarly interesting one. It is that of a man standing between the employer and the workman, where he commands a complete view of the positions of both, and from which he directs the difficult but broadly instructive work of bringing their efforts into harmony. He speaks with an accurate appreciation of the needs of the employer and the sentiments and purposes of the men. His vital concern is to secure that which is best for both sides. The extreme practicability of his attitude will commend itself to all who are interested in works management.—THE EDITORS.

zations were so obstructive to the development of trade that the employers were compelled to fight for their very existence. Under such circumstances there need never be a doubt regarding the result of the struggle. It would seem from the actions of labor and the threats of some of its leaders, that the same mistake was to be repeated in the United States. The unions object to piece work, and to one man running two or more machines. We find them also in many cases objecting to labor-saving machinery, and, in fact, to pretty much everything that tends to cheapen or promote production.

The excuse is sometimes given that measures of this kind, which increase the productive capacity of the workman, throw others out of employment. This is the same old charge that has always been brought against labor-saving machines and methods, and its absurdity has been proven too often to receive much consideration here. It should be well understood that a certain amount of production is necessary to maintain existence. That amount varies in proportion to the increase in the population of the world, and to the advancement of civilization. As people become more civilized and enlightened their wants are increased; to meet the increase there must be a corresponding improvement in the methods of production. Stop that improvement, and you stop civilization. Nature, working through the avarice and ambition of man, supplies this improvement. The time may come when all labor will be paid according to its productive capacity—when men will be paid according to their individual efforts. Theoretically that is the only just method of remuneration. It is placing the matter where it belongs, under that inexorable law of nature—the survival of the fittest. All development is in that direction, and competition in manufacturing demands it. The observance of this law does not require that the weak should be left to suffer; but means other than the restraint of the fittest should be provided for their care.

From the published reports of the discussion on this subject at the last year's meeting of the International Association of Machinists, it would seem that the one predominant idea seemed to be the strangling of individual ambition. It is right and proper that men should stand united against oppression, or anything that serves to lower or degrade them; but I fail to see where piece work in any fair and proper form can produce such an effect. The organization that strives to curb the energies or worthy ambition of its members will come to grief, sooner or later. Enforced stagnation has no place in healthy industrial life. Had it not been for the incentive that was offered to individual energy, America would not be occupying the proud position she holds to-day.

Such a policy has produced wealthy men, practically every one of whom is a shining example of what it is possible to accomplish by well-directed efforts. All honor to those who have risen from the pick and shovel, the chisel and hammer, or the axe in the forest, to the possession of millions. The money which they control is not hoarded, but invested broadcast throughout the land, not only for their own benefit, but for the benefit of those less fortunate.

Labor organizations are certainly working on the wrong principle when they encourage their members to retard production by the performance of a dishonest day's work. They are no doubt honest in their convictions, but blind to the inevitable nevertheless. President Fox struck the nail on the head when he advised the Iron Molders' Union to cease opposition to molding machines. Suppose that advice had been given years ago, when molding machines were first introduced; or suppose there never had been opposition, but, on the contrary, the men had recognized the inevitable and accepted the machines as a benefit to the foundry business and the world in general, and endeavored to make the best use they could of them! Suppose, again, that the machinists' convention had declared for a good, fair day's work, whether they were watched or not; that they would exert themselves while running a machine, as when working at the bench or on the floor, even though it meant the running of several machines to do it; that they had given their members to understand that they were hired to work, and not to sit on a three-legged stool and watch a planer travel back and forth for hours, with practically little or no necessity for their attention, because the automatic features on that planer—or any other machine which made constant attention unnecessary—were paid for by the company, who should not be expected to make further expenditures by having them sit down and watch it do its work; that the man who attends a machine tool has no more privileges than his shopmate who swings a hammer, "pushes" a file, or jumps around an erecting floor unceasingly throughout the day—in a word, suppose they had come out boldly with instructions to their members to do everything within their power to perform a fair day's work and leave their employers no chance to say they had done otherwise, and to accept in a friendly spirit all economical methods and machines, providing they were given an opportunity to increase their earnings without detriment to their health. I do not mean to insinuate that a small day's work is the rule among machinists, but we do know that there is a great deal of what we call "hanging back," and as it is just this "hanging back" that makes piece work in some form

a necessity, one would naturally suppose the workmen would endeavor to remove the cause and place themselves in a true light and an advanced position as an organization before the world.

I fear, however, that this is asking too much of human nature, and that systems of reward and penalty must be employed to obtain the desired result. The system in general use is piece work in various forms. Plain old-fashioned piece work, with a definite price on every operation, is the oldest and best known; it has its friends and its enemies, just as it has been properly or improperly applied. There are hundreds of factories where it is in successful operation, many of which would now be out of existence were it not for the benefits of the piece-work system. The principal objection raised against it is the plain, bare-faced manner in which the earnings are regulated—a direct cut in prices when the workmen are earning what is considered an excessive amount. Of course, it is human to resist such reductions; but we have yet to hear of the system under which the workmen's compensation will not be subject to revision. There is no man living who can always correctly estimate the price or time for every operation, particularly on new work. It is not necessary that he should, so long as the workmen have sufficient confidence in the employer's justice to know that he will treat them fairly. I have frequently known men voluntarily to suggest reductions in prices which they considered too high. They did not do it through the expectation of any favors, but from the knowledge of the fact that if the prices had been too low they would only have to prove them so and they would be raised without hesitation. When this confidence exists, piece work in any reasonable form will be successful. After all, it is not so much the system that counts as it is the men behind it. The direct open cut is, in my opinion, a commendable feature rather than otherwise, because frankness, above all things, is necessary in dealing with workmen. If you have a proposition to make to them, first satisfy yourself that it is fair; then offer it in a straightforward, manly way and in a clear and comprehensive manner. Practice no deception in order to gain a point, because they are very quick to detect the "colored gentleman" in any "wood pile" in which they are interested.

While employers in general aim to treat their help justly, it is unfortunately true that they do not always succeed. The workman is not alone to blame for all the troubles that arise. I have frequently noticed cases of gross injustice as the result of what we might term long-range management, when the systems of remuneration are left in the hands of petty officials without knowledge of shop practice or the

whims of workmen, but with any amount of superciliousness and the greatest contempt for men in overalls. To this cause can be traced very much of the objection to piece work. Under such circumstances we generally find all the men employed on a certain class of work earning practically a uniform rate of wages. They are permitted to earn a certain percentage over their regular day rate; just as soon as they go above that they will be cut, and they know it; consequently, through compassion for their weakest shopmate, if for nothing else, they will hang back within the limit. If those in charge of such matters would take this into consideration, exercise better judgment, and allow men to earn a profit according to their productive ability, there would be much less trouble with piece work. By holding them down to a uniform rate and not permitting the best men to earn more than the worst, a condition is produced practically identical with that demanded by some of the unions, viz., a uniform day rate.

Another cause of trouble, also, is incivility on the part of those who deal directly with workmen. There is no reason on earth why a workman should not receive a civil answer to a civil question. This might be considered a small matter, but it is a source of irritation, nevertheless. I have also seen men in a factory defrauded of their wages on the merest technicality—wages earned under the most trying circumstances. Of course cases of this kind are extremely rare, but they certainly create a bad impression whenever and wherever they occur. We find cases also where, through fear of strikes and labor troubles generally, employers submit to all sorts of abuses from their help. The snail-like movements of the workmen usually indicate such a condition. Speeds and feeds are of the lowest. If on piece work, they generally get the price they ask for. When they want a day off, they take it without notice to their foreman. The employer who tolerates such a condition through fear is in reality spoiling his help and encouraging the conflict he wishes to avoid, because, sooner or later, competition will compel him to adopt different methods. The workmen may think that such a state of affairs is to their benefit, but in this they are mistaken, for the reason that it is unjust, if for no other, and consequently detrimental to all concerned. I have also seen men occupying the highest positions fomenting discord and trouble among the workmen in order to gain some advantage over a brother official with whom they are in dispute. Such men are a curse to any institution in which they may be placed. All quarrels among officials should be settled in the office and not carried into the shops. Troubles of this kind among officials usually arise through unwarranted interference, and

managers should have sufficient strength of character to control them. There is no place on earth where the ability to mind one's own business is more desirable than in the organization of a modern factory.

Workmen are to a certain extent what employers make them. Petty injustice, bad example, and weak management are responsible for much of the enmity that exists between employer and employees. It is the duty of capital, in its own interest, to enlighten labor and thus remove many wrong impressions from its mind. I am pleased to notice that a step in this direction has been taken by Mr. W. B. Pearson, of Chicago,* and it is one that should be followed up by others. But what is more to the point, information of that kind should form the subject of considerable discussion in the meetings of organized labor. If workmen were more familiar with business methods they would be in a better position to realize why their demands cannot always be granted. If the employer who considers himself right in his own views and contentions on account of his superior intelligence would only take the trouble to enlighten his help on the methods, risks, trials, and troubles of conducting a successful business generally, they might see things in the same light as he does. If enlightenment is beneficial to him, it should be equally so to them. The solution of the so-called labor problem is simply one of education—an education by which a knowledge of, and respect for, the rights of other men is obtained. Clear open-handed justice and plain straightforward dealing are the principles that should be followed in managing help. No quibbling, no underhand business of any kind. Meet them face to face without fear, and treat them justly. If this course fails, fight them with all the power at your command.

Workmen should understand that there are two sides to the questions in which they are interested as well as there are to all others, and that their side is no more likely to be right than their employers'. There should be no antagonism on principle, because the workman is less liable to be in possession of all the facts controlling the question at issue than his employer.

While in conversation with me, a labor leader cited in support of the machinists' union the extraordinary wages received by the locomotive engineers. He seemed to attribute this to the mere fact of

* The reference is to an admirable pamphlet entitled "Where Does the Money Go?" giving, for the instruction of the workman, a clear synopsis of the total expense of manufacturing, including all the non-productive elements usually ignored by the labour advocates. Its purpose is to dispel the fallacy that the employers' whole outlay is included in the items "labour and materials." The booklet is deserving of the widest distribution. We believe that those who are interested can secure copies from the National Metal-Trades Association, 95 Liberty street, New York.

organization. He did not seem to recognize the fact that a large number of the machinists object to running machine tools at the feeds and speeds which the manufacturer considers necessary to realize a fair return for his investment in the machines. Who ever heard of an engineer deliberately reducing the speed of his engine below the rate at which the railroad company decided it should be run? On the contrary, they accept the speeds cut out for them, and instead of reducing the efficiency of their machines, under the mistaken notion that it will afford employment to a greater number, with their life in their hand they push them up to the prescribed limit and take a pride in their performance. Such men, in my opinion, richly deserve every dollar they receive. I will admit that organization has contributed to their success, but it is organization of a kind which other unions might copy with profit. As stated in the June number of *THE ENGINEERING MAGAZINE* all mechanical development is toward an intensified production, because the wants of civilization demand it, and every obstruction which we place in the path of that development only adds to our burdens unnecessarily. We should not antagonize honorable means or methods by which production is intensified, because, on the whole, it is for man's benefit. We notice this in the continual shortening of the hours of labor. Do not think for a moment that the blessing of shorter hours is the result of organized labor's demands only—not by any means. The prime factor in its realization is the use which has been made of labor-saving machines and methods in promoting and reducing the cost of production. Brains came to the relief of muscle, and will continue to do so; therefore it is detrimental to the interest of labor to discourage or prohibit the use of such improvements. It was the free, active mind, and the big, generous day's work of the American mechanic that has secured the present commercial supremacy of the United States. For this he has received the highest compensation ever paid for like services anywhere, and he must continue to receive it so long as he maintains his superior productive capacity. It is the duty of manufacturers, as a body, to see that there are no unjust restrictions placed on the ambitions of workmen, even though it be only to increase their earnings through the medium of a large day's work. It is to the brain and brawn of the manufacturing industries that we must look for support in our efforts to keep in the front rank of civilization.

THE APPLICATION OF WATER-TUBE STEAM GENERATORS FOR NAVAL SERVICE.

By B. H. Thwaite.

ALL the great powers are rivalling each other in their designs and efforts to obtain additional colonising territory, to expand their empire, not only for the purpose of providing areas for the emigration of their people, but in most instances to provide close preserves for their trade and commerce. The effect of this 20th century desire for imperial expansion, upon the character of the defensive and offensive equipment, is indeed revolutionary. Each of the great colonising powers will secure battle-ships of the maximum speed and power, for the greatest distances. Therefore, the question of the most efficient steam generator is of paramount importance, and this supreme position has in quite recent years been more fully recognised by engineers.

Formerly the steam boiler never received the serious consideration of scientific students, most, if not all, the attention being devoted to the improvement and investigation of the steam engine. The result of this neglect is, that at the expiration of more than a century from the birth of the steam engine, there is a most striking difference of opinion amongst engineers upon the respective qualifications of the water-tube steam generator and the shell or cylindrical steam generator: one group of opinions holding that the latter type is alone worthy of confidence for naval work, whilst the other group considers that some one of the various forms of the water-tube boiler contains all the qualifications to satisfy the exigencies of naval engagement.

Another result of a want of the absence of knowledge of all the subjects that bear upon the correct design of a steam generator, and one that is ever associated with ignorance, is the fact that an innovation in established procedure or design is prevented from lack of confidence. This want of confidence has given birth to the principle of the policy of follow-my-leader, which has been adopted by most of the naval powers. Of all these France, and in a less degree the United States, deserve the praise that should be unstintingly given

The introduction of steam at sea has imposed two great problems—one the reorganisation of the *personnel* directing and fighting the ship, the other the perfection of economy and convenience in the great central source of power. This second and purely mechanical question will be thoroughly investigated by Mr. Thwaite in this issue of the magazine and the number for November following.—THE EDITORS.

to any nation that adopts the brave part of pioneer of new developments in structural science applied to battle-ship construction.

In the work of pioneering the British admiralty has hitherto notoriously lagged in the rear, and its only claim to recognition is the fact that it is of all the powers the most generously endowed with purchasing power by a sadly non-reflecting people.

The requirements of the navy are quite distinct from those of the mercantile marine, in which a vessel leaves one port for another at a uniform speed, and is rarely, if ever, called upon to increase her speed suddenly to the maximum possible.

The highest naval authorities have laid down certain inexorable conditions, and these conditions are such as to differentiate the naval steam generator from that of the mercantile marine. These are:

First.—Must be able to drop down from full high speed to dead slow, and vice versa.

Second.—Must provide a high evaporative potential along with a low weight of structure, and these qualifications must be associated with a satisfactory factor of heat utilisation in power development.

Third.—In the fullest speed periods, no smoke that will serve as an object of discovery for the enemy shall issue from the funnels.

Fourth.—The boiler must be compact as possible, occupying the least possible cubic space. Full pressure steam must be raised from the cold in one hour.

Fifth.—All the conditions specified must be secured without involving any risk or danger that might disturb the confidence of the firemen and supervising staff.

The explanation offered by a former official of the British Admiralty for the adoption of the water-tube boiler in place of the shell or Scotch cylindrical generator is as follows: In the plans of the battle-ships, submitted to the British Board of Admiralty in 1891, shell marine boilers were proposed. The board was informed that 12 hours would be required to get up steam under stress, but that it would not be advisable to press the boilers, and that if the safety and durability be considered, even 24 hours would not be too much. The explanation preferred was that the abnormally thick plates of shell boilers necessary to permit the high steam pressures to be established, made it dangerous to press the fires to raise steam quickly, owing to the varying degrees of expansion set up and the serious strains associated with them. The manœuvring disadvantages that the slowness of getting up steam involves decided the British Board of Ad-

miralty to adopt the water-tube boiler of the Belleville type; the decision appears to have been rather abruptly taken, and a very handsome sum was paid to M. Belleville for the right to use his patents, Lord Spencer, a prominent Liberal peer, being at the time head of the Admiralty Board.

It is notorious that in peace time the nerves of the men are disturbed by the unexpected giving way of a boiler or its steam pipe joint. What, therefore, would be the effect in time of war?*

The fact of slow steaming associated with the use of shell boilers is undoubted, and it is a consequence of one of its advantages, that is, its great reserve or potential of evaporative power, owing to the considerable weight of water it contains.†

Of course, in a naval engagement, the piercing of the shell of this type of boiler may release such an enormous accumulation of energy as to involve the entire destruction of the vessel.

In the opinion of the author, and his opinion is shared by those who have thoroughly investigated the thermo-physical effects brought into play by the shell boiler, the water-tube boiler now occupies an assured position as part of the evolution of steam-power thermodynamics, and will displace for naval purposes, in one or other of its types, the shell boiler, a product of irrational conservatism in engineering structural design.

Unfortunately the discussion of the merits and demerits of the two types of steam generators has been astoundingly clouded by the blinding influence of prejudice. The author has, therefore, tabulated as fully as possible the pros and cons of both classes.

SHELL STEAM GENERATOR.

Pro.

1.—If a flame tube leaks it can be plugged; there is no necessity to draw from the fires.

THE WATER-TUBE STEAM GENERATOR.

Pro.

1.—Steam far more quickly raised from the time the fire is lighted in the grate, 40 to 60 minutes sufficing.

* The author has had a personal experience of the complete demoralisation of a torpedo-boat boiler-room staff by the unexpected blowing out of a flange joint in a locomotive type of boiler operating at a pressure of 200 lbs. The men completely lost their heads and tumbled over each other in their anxiety to reach the hatchway ladder.

† As an example of the seriousness of slow-steaming, without referring to the recent bad records of the British cruisers—the Terrible and other vessels—one can instance the incident reported in the Spanish war to the effect that 3 hours were lost by the Brooklyn, and 2 hours 40 minutes by the New York, at a most serious crisis in the naval engagement.

It is further reported that it was found to be most difficult, even with the application of the fire-banking principle, to keep up steam in all the boilers so as to be ready for action.

A partial exception was however found during the same war in the forced-draft boilers of the St. Louis and St. Paul; these two boats after banking their fires for some hours were able to raise the speed from low cruising degree of speed to that of 20 knots in 8 minutes.

SHELL BOILER. *Pro.*

2.—Less liability to danger through the introduction of saline feed water, lubricants or agents that initiate and sustain corrosive effects.

3.—Greater structural strength to sustain shocks that are inseparable from marine work. Also less liability to serious damage or by the ill-usage of stokers.

4.—The evaporative efficiency with moderate fire grate pressures is as good as can be obtained with the average water-tube boiler.

5.—Greater reserve of power owing to greater water space provided.

6.—With carefully banked fires a great potential of evaporative power can be obtained in half an hour.

7.—Sustained efficiency in long-distance trips, compared with the Belleville type of generator; claims under this head can be justified, and with them others as important.

Con.

1.—Slowness in getting up steam from the cold.

2.—Imperfect and indefinite circulation.

3.—Unequal expansion and contraction of the metallic portion constituting the heating surface.

4.—Owing to the rigidity of structure, defects 2 and 3 involve sooner or later—owing to the stresses—if not actual rupture, serious and costly repairs.

5.—The repairs involve the employment of skilled boilermakers.

6.—The removal of a shell boiler involves the use of special lifting appliances and its transport is difficult and inconvenient.

7.—After the repairs have been effected, it is very rarely possible to secure with safety the original steam pressures.

8.—Greater weight of structural material in proportion to power output.

WATER-TUBE BOILER. *Pro.*

2.—Far greater power output in proportion to weight of boiler.

3.—Therefore higher speeds are obtainable.

4.—Easily transportable.

5.—More adaptable and accessible for repairs and renewals; no special lifting arrangements are required.

6.—Easily constructed.

7.—Less cubic space required.

8.—Can be more or less readily inspected and cleaned.

9.—Circulation more or less definite and continuous, and improves with the increase of rate of combustion.

10.—More or less adequate provision made for the effects of expansion and contraction.

11.—Greater safety. No danger of the vessel being wrecked by explosion.

12.—No necessity for reduction of working pressure when an old tube is replaced by a new one.

13.—More or less easily accessible for inspection and repair.

14.—As the heat of combustion is greatly reduced (when the gases reach the upper tube), the danger of these tubes being raised to a red heat, in the event of the tubes being momentarily denuded of water, (the effect of passage through rough seas) is less.

15.—The experience of the South American war demonstrates that the water-tube boiler gives advantages of great tactical importance.

Con.

1.—More difficult to maintain uniform steam pressures.

2.—Tendency of the lime and magnesian salts to deposit in the boiler.

3.—The reduction and evaporative efficiency of the generator tubes by incrustation and the tendency to become dangerously overheated.

4.—Difficult during working operations to ascertain condition of tubes.

SHELL BOILER. *Con.*

9.—Cubic displacement in proportion to evaporation potential is greater.

10.—Necessity of reliance in the character of the structural metal employed is much greater than in a water-tube boiler.

11.—The considerable storage of evaporation potential provided by the water carried may in case of accident actually sink the vessel.

12.—It is necessary when high steam pressures are required to use very heavy shell plates $1\frac{1}{4}$ to $1\frac{1}{2}$ inches thick, a condition fatal to uniform expansion and, *per contra*, contraction effect.

13.—When forced draft is employed with closed stoke-hole the effect of the admission of this air when the fuel is being fed upon the furnace crown is most serious.

14.—The same effect, forced blast, is liable to produce the bulging of the fire-boxes, owing to vivid combustion being prolonged through the tubes to the box.

15.—The tubular part of boiler is practically inaccessible, and this part is the *locale* of the greatest accumulation of deposits, and thorough cleaning is also impossible.

16.—Owing to the small grate-surface ratio to floor space occupied dangerous degrees of forced draft are unavoidable.

17.—The dangerous possibility that the flames may reach the upper tubes which may, owing to neglect and during the passage through a rough sea, be uncovered with water.

WATER-TUBE BOILER. *Con.*

5.—Any damage done to a single tube involves the drawing of the fires and the emptying of the boiler. Tendency to steam escape owing to the composite character and numerous points of the structure.

6.—Composite character of structure less suitable for the shocks inseparable from marine work.

7.—Great number of constructional points.

8.—Greater attention required in supervision.

The following properties may be considered essential in a satisfactory marine steam generator for naval service:

First.—That there shall be perfect combustion of the fuel at all rates of grate combustion and without involving the production of a smoke trail that will be a dangerous signal to the enemy.

Second.—That the transmission of the heat produced in the water to be evaporated shall be as complete as practicable, and be either so well distributed, or the water circulation so perfect, that no dangerous expansion or contraction effects shall be produced.

Third.—That all associated chemical, thermal, or physical effects that tend to deteriorate the stability shall be reduced to a minimum.

Fourth.—That the steam generated as it leaves the stop-valve shall not carry more than a negligible proportion of suspended moisture.

The perfect combustion of the fuel is dependent upon the proper supply of air. With bituminous coal, such as is used in the furnaces of marine boilers, the proper supply of air varies according to the proportion of volatile hydrocarbon present. When the fuel consists wholly of fixed carbon, all that is required is to provide a sufficient weight of air to oxidise the carbon either to carbon monoxide, adding a secondary supply of air over the grate and fuel-bed to oxidise this carbon monoxide to carbon dioxide; or—the alternative—to supply a sufficient weight of air, employing a thin bed of fuel, to oxidise the fuel thoroughly and directly to carbon dioxide.

In the case of bituminous coal these direct operations are not practicable, and a certain amount of finely divided carbon is deposited as soot, which must be re-oxidised in a suitable combustion chamber, sufficient air being admitted for the purpose. If the hydrocarbons are brought into contact with the water-surrounded heating surface of the boiler before a full adequate supply of air permits their being completely oxidised, dissociation takes place, with the production of smoke. When the volume of air required to oxidise the fuel burnt at ordinary rate of combustion is realised, there will be no more designs with insufficient combustion space over the grate, and there will always be provided a secondary and well-distributed air supply over the surface of the fuel on the grate. Although the water-tube boiler offers opportunity for correct design in this respect, inadequate combustion space and imperfect air-supply arrangements are striking defects in most of the various forms of water-tube boilers.

In the case of the shell boiler, with its internal furnaces, there is a structural limit to the cubic space available for the initial combustion, and the satisfactory application of a secondary supply of air is most difficult. The cubic space through which the gases of combustion have to flow is greater than that of some water-tube boilers, and hence for moderate fire-grate pressures the evaporative efficiency is as high as in those water-tube boilers which have an inadequate combustion space.

It should be considered an axiom of perfect steam-generator design to provide a cubic space in the combustion zone equal to the maximum demands; if these are satisfied the space provided will be found satisfactory for the lesser air pressures.

The tactical dangers of imperfect combustion and its resultant smoke were strongly illustrated in this year's British naval manoeuvres. The battle-ship *Ariadne*, equipped with Belleville boilers of the non-economiser type, proved to be a veritable coal eater; her empty bunkers compelled the rest of the fleet to risk a dangerous action in order that she might have her coal supply replenished, and from her funnels there issued, it is reported, a long trail of dense smoke that would have been easily observable by the enemy miles away.

An example of the ruinous cost of imperfect combustion is seen in the voyage of the *Europa* from Europe to Sydney, Australia. The vessel is equipped with Belleville boilers and with high-class engines, yet the fuel consumption attained the figure of 5 pounds of coal per horse-power hour. The total cost on this trip over what would have been required with perfect combustion is placed at £20,000.

All water-tube steam generators possess in a lesser or greater degree of perfection the feature of definite circulation. This characteristic differentiates them from any existing type of marine steam generator. Of course, even with this valuable quality, the structural arrangements may be so bad as almost to nullify the advantages.

It is obvious that the frictional resistance to the flow of water is less in straight than in curved tubes, and that abrupt diversions seriously reduce the momentum and tend to produce eddies which seriously retard the rate of flow and tend to produce the deposition of suspended matters it is the object of circulation to avoid.

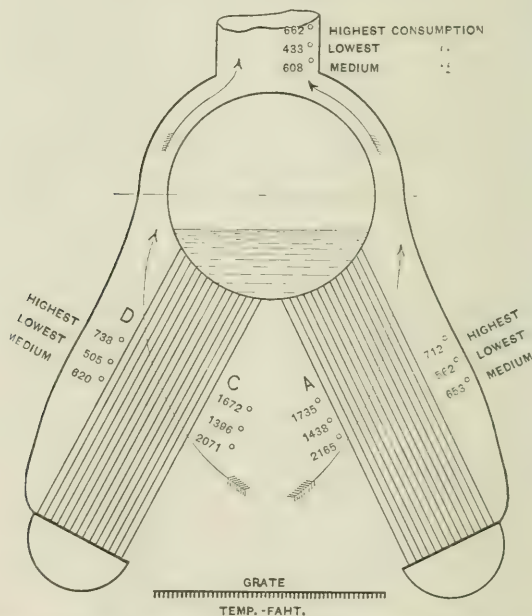
If heat can be equally as well applied to a vertical as to a horizontal tube, the more nearly vertical the tube the better; in practice the application is difficult, and the solution is found in the inclination of the tubes, the angle of inclination varying greatly in different water-tube boilers. Associated with this problem is another—to secure the form and direction of tube that will provide the greatest separation of steam. Further, there is the tendency to form steam spaces in the tubes. When a tube is abruptly curved, or is too horizontal, if exposed to the hottest zone of the furnace these steam spaces may be produced, and immediately the tube becomes raised to a critical temperature dangerous oxidation may be set up. See remarks on oxidation. A well-designed arrangement of circulation will prevent these dangerous points of steam formation.

In designing circulating arrangements the following precautions may be remembered:

- a. Let the tubes be as direct as possible.
- b. Avoid abrupt bends; let the curves, if their use is inevitable, be of as large a radius as practicable.
- c. The direction of the tubes (and this applies more directly to the part exposed to the most intense zone of heat) should be as nearly vertical as practicable.
- d. The return water tubes or tube down-comers should have an adequate area, so as to assist rather than retard circulation.

The escape of steam bubbles, when formed, is assisted by the vertical direction of tubes, but is seriously retarded by horizontal ones, and especially those having abrupt bends. Of course the evils of the latter conditions will be greatly aggravated if the tubes are small.

FIG. 1 - SHOWS THE TEMPERATURES OF COMBUSTION DEVELOPED IN A YARROW TYPE OF WATER TUBE SG.



The degree of heat transmission is a function of the velocity of the heat absorbing liquid. With water, according to Sez (*Traité de Physique Industrielle*), the rate of transmission varies roughly from 1 to 5, the degree depending upon whether the water is quite stationary or in rapid motion; in other words, the transmission is 5 times greater if the water is flowing rapidly than if stationary.

Active circulation stimulates vaporisation.

The greater the velocity of circulation the greater the durability of the tubes.

The effects of expansion and contraction, so destructive to the shell type of steam generators applied in high-pressure marine engines,* are controllable in the well designed water-tube boiler.

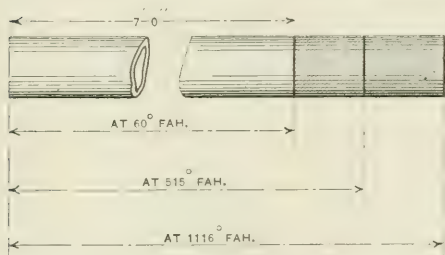


FIG. 2. SHOWS, FULL SIZE, THE EXPANSION OF A GENERATOR TUBE 7 FEET LONG, CONTAINING WATER AT 300 DEGREES F., AND HAVING A SURROUNDING HEAT OF 2,000 DEGREES F., AND THE SAME TUBE CONTAINING WATER AT 300 DEGREES F. WITH A SURROUNDING HEAT OF 730 DEGREES F.

It is self-evident that the degree of expansion is a function of temperature, and the uniformity of such temperature. Therefore, the more perfect the circulating arrangements, the greater the uniformity of temperature of the generator structure, and the less the expansion effect. If a tube is rigidly attached at one end only and is quite free to extend itself at the other, the expansional influence of heat is quite harmless. The evil is not always a consequence of expansion, but may be the result of the subsequent contraction effect.

Again, if a tube attached to rigid connections at both of its ends is sufficiently curved, the expansional effect is simply absorbed in increased curvature effect. Assuming that the connections to the rigid places are properly made, both methods of meeting expansional effects are satisfactory. It is strongly inadvisable to employ a screw-thread connection, because of its tendency to leak and the difficulty of removal. Either expanded or coned joints are to be preferred.

The question of durability, involving thicker tube sides, will affect somewhat the radii of the curves that can be employed.

The adequate compensation for the fresh water evaporated is more important for water-tube boilers than for the shell class, because the margin of safety is less, owing to the small weight of water stored in generator.

The importance of automatically maintaining a steady flow of fresh water to correspond with the proportion evaporated is well rec-

* According to *Engineering*, July 27, 1900, "The record of the Bellevilles is spotless white, compared to the history of the tank in the British Navy just previous to its suppression."

In the test of the *Royal Sovereign*—"after a three hours' test out of what should have been a four hours' run at full speed, the trial was stopped on account of the leaky tube ends."

ognized by the makers. Unfortunately some of the apparatus so far devised is more or less complicated, and is liable to become damaged by the influences of oxidation or corrosion.

In a well-designed and organised fleet it should never be necessary under any conditions to have to rely upon sea water. If this is inevitable, it would be better to provide a few shell boilers as auxiliaries, because this class of steam generators is rather more suitable for this character of feed. However, all the progressive admiralities, thanks to one of the serious lessons of the Spanish-American war, are becoming alive to the importance of providing for their fleets that are equipped with water-tube boilers, a sufficient number of vessels whose object is to distill sea water and provide an adequate supply of fresh water for every vessel in the fleet.

The great *bête noir* of boiler attendants is the incursion of sea water into the feed, owing to the defective tubular condensers. If the circulation is rapid, and the arrangements for effecting the separation of sediment are satisfactory, this impurity will not prevent the water-tube boilers from being worked for some considerable time, although the increased tendency to prime caused by the introduction of sea water will involve extra attention.

If the fresh water contains lime or magnesia, these impurities will have a tendency to deposit from hot water on surfaces where the water is stationary. Here, again, the importance of rapid circulation cannot be exaggerated. It must be obvious that all sediment-depositing chambers should be placed external to the boilers and in readily accessible positions. Another undesirable intruder is the grease of lubricants from the motive-power machinery, introduced with the condensed water.

With a water circulation of sufficient velocity, assuming that the density has not been allowed, by neglect, to become too great, it is impossible for the impurities to deposit. The scouring or erosive action of the water in the tube sides will prevent this. It is, of course obvious that there will be more erosive action on the surfaces of a small tube than on a large one, in the direct proportion to the ratio of the cross-sectional area to the internal circumference.

The convenience of internal and external approach should be one of the advantages of an ideally-designed water-tube boiler. In this respect it has intrinsically an advantage over the shell type. In several of the designs this advantage has been neglected. In the shell boiler it is practically impossible to obtain access to the interior part in which the nest of tubes is located. This is self-evident by examination of

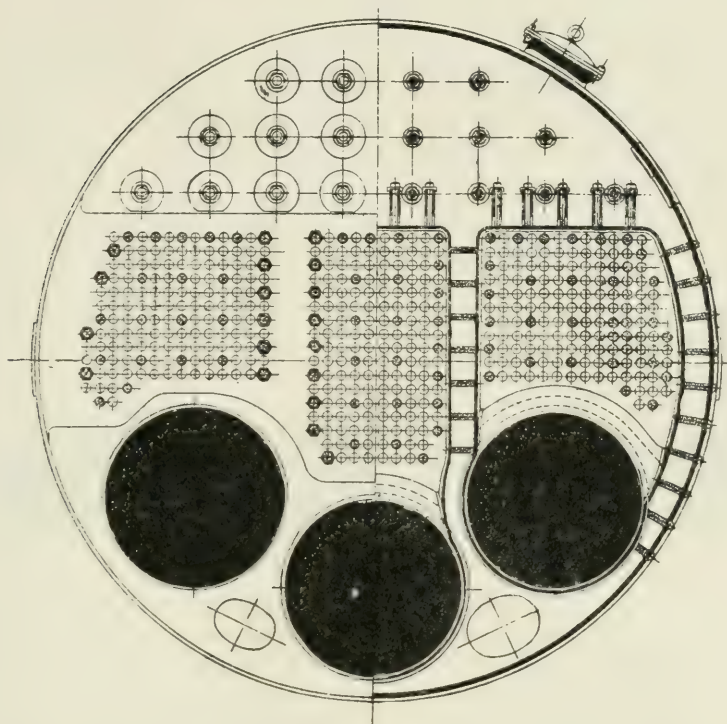


FIG. 3. SECTION OF SHELL BOILER, CHINESE WAR-SHIPS HAI TIEN AND HI CHI.

Fig. 3, representing a section of the shell boiler of the Chinese war ships Hai Tien and Hi Chi.

The inside of every tube should be accessible for examination, and all the accessory vessels should be also and conveniently approached, internally and externally.

It should be possible readily to remove and renew a tube. Of course, in a nest of small tubes, if the defective tube is in the middle of the nest, it may be necessary to remove all the tubes between it and the outsides; but if time is urgent, the tube should be accessible to temporary closing with a plug. Removable casings should be provided to permit the immediate examination of the nest of tubes, and the casings should be well and stiffly, but not too heavily, constructed, and none of their rivetted seams should be exposed to the possibility of flame contact. This is important, because the warping of the casings provides apertures for the entrance of air that reduces the chimney draft and disturbs the combustion arrangements.

The question of durability has assumed a position of considerable

importance, because the spokesman for the British Admiralty, in his report to the British Parliament, stated that the small-tube type of water-tube boilers is not nearly so durable as the large-tube, and especially the Belleville type, the explanation being the fact that the tubes of the latter are thicker. But the remedy for this is simple. Let the sides of the small tubes be thickened. There is no insuperable difficulty in effecting this.

The influences that reduce the serviceable life of the water-tube boiler are those of internal and external corrosion and oxidation, and the rapid alternating effects of expansion and contraction, and to a very inappreciable extent, the erosive influences of the rapid currents of water. See Fig. 4, shewing the burst tube taken from a Belleville steam generator of the Orlando.

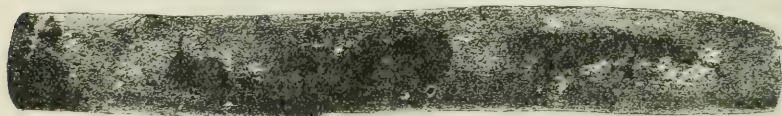


FIG. 4. BURST TUBE FROM BELLEVILLE BOILER ON THE ORLANDO.

The effect of corrosives in reducing the durability of shell boilers is well known. Fortunately, by the displacement of vegetable oil by that from mineral sources for all lubricating requirements, this organic agent, one of the greatest sources of this insidious but destructive action, has been removed, but corrosive effects do still occur, their origin being traced to the inclusion of air in the boiler, and the effect of moisture. The water-tube boiler has here again advantages over the shell type. Rapid circulation will remove the source of the trouble from its *locale* of action. The proportion of air that can be enclosed in a water-tube boiler will be less than that in a shell type. Air is always present in fresh feed water, and when the boilers are empty the space is air filled.

Experiments have proved that corrosion is promoted by contact with a combination of air and moisture, the effect being greater in proportion to the weight of carbon dioxide existing in the air. The exclusion of the air, therefore, removes two of the active agents. The water feed tanks supplying the feed pumps should never be allowed to become empty, because this would incur the sucking of air and its introduction into the boilers.

The greatest protection should be given to water-tube boilers when a naval vessel is not on active service. When a vessel is ordered out for active service her water-tube boilers should be given a dose of

lime, say 8 pounds of lime to every thousand horse power, added to feed tank. This agent will neutralise the influence of any enclosed air on the water-covered surfaces, and if there is leakage of sea water into the feed, ordinary lime of commerce, unslaked, should be daily added in proportion of 1 pound to every thousand indicated horse power of the boilers.

Rolled zinc blocks placed in metallic contact with the metal to be preserved can be placed in the steam and water drums with advantage. Quick lime should be placed in the boiler, when not at work, to absorb the moisture, and the boiler should then be made air-tight. Baskets containing coke fires can be placed inside the generators. The CO and CO₂ produced by the combustion of the coke will drive out the air: the manholes should then be carefully fastened up.

The metallic surfaces that are exposed to steam and water intermittently are more seriously influenced by corrosion than the surfaces continuously exposed to either water or steam. When this surface is of a tubular form, one remedy is to galvanize the tubes internally; and this protective process is becoming popular for all kinds of tubes, large and small, that are used on water-tube boilers.

The efficiency of the water-tube boiler depends very greatly upon the character of the labour and supervision of the firemen. Therefore, the health conditions of the work should be considered, and more especially in water-tube generators. Where a pair of boilers are placed with their fire-doors opposite each other, the stoke-holes in the hot days of summer or in tropical climates become perfect infernos. The author suggests that, wherever possible, a wall of small tubes should divide the stoke-hole or form one of its sides, and through these tubes sea water should be constantly pumped. Such a system would interfere with closed-stoke-hole arrangements, but would make the conditions of the fireman's life so satisfactory that there need be no neglect of his duty to the boiler.

The importance of dry steam is pretty well acknowledged by boiler makers. It is far more difficult to generate dry steam in water-tube boilers than in the shell class, but by an ingenious arrangement of baffle-plates fixed in the steam drum, the suspended water is separated from the steam before the latter is allowed to flow to the engine.

So much suspicion has been created owing to the serious disparity between the working every-day service results and the test results of naval vessels, that some remarks upon the misleading character of short tests are necessary. An example is found in the trip recently made by the battleship *Terrible* (sister ship to the *Powerful*), from

Hong Kong to Taku. The service was of serious national importance, carrying troops to rescue the British in Peking. The trip, a distance of some 1,800 miles, was effected in $5\frac{1}{2}$ days, equivalent to a speed of only $13\frac{1}{2}$ miles an hour, instead of the 22 miles' speed recorded in the short-period tests. The Terrible and the Powerful are supposed to indicate 25,000 horse-power.

The only tests of any system of power-production equipment that can be considered absolutely representative or reliable are those extending over a period of several days. It is astonishing that this obvious truism has not been practically acknowledged. It is the old story—no one cares to overcome the inertia of common practice. A test under ordinary working conditions, with a competent staff of firemen, would provide data that could not be disputed, and the inclusion of such a test in the contract specification would doubtless be accepted by all ship-builders. Such a test could be confined as far as the water-tube steam-generator efficiency is concerned to the ratio between the weight of fuel burnt at specified air pressures, and the water evaporated to a condition of dry steam measured from and at 212° Fahr., a specific weight of steam being allocated to produce a given indicated horse-power, say 17 pounds. The calorific value of the fuel should be tested by the Berthelot-Mahler calorimeter and the evaporation be reduced to a standard to be agreed upon of calorific value. The results of such a test would enable the character of the steam-generator system to be determined by the equation of efficiency.

It is obvious that if the weight of a boiler, *per se*, is low in proportion to its evaporative power, this factor is by itself a valuable index of character, but *only* when its degree of heat utilisation efficiency is also satisfactory, otherwise the weight of fuel to be carried for a given period of power development may destroy the low-weight advantages possessed by the boiler.

The proposed equation is as follows:

Let A be the weight of fuel burned per square foot of grate, corrected by calorimeter to a standard calorific value; B, the number of pounds of water evaporated into dry steam per pound of fuel burned per square foot of grate surface; W, the total weight of the steam generator; then will the

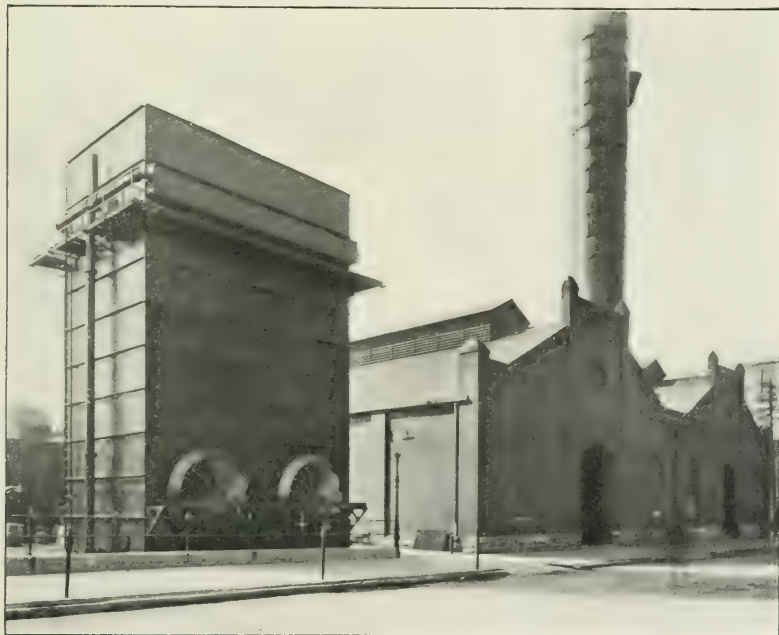
$$\text{Actual useful efficiency} = \frac{A \times B}{W}$$

The next article will discuss various representative types of water-tube boilers used in naval service.

THE CENTRALISATION OF THE STEAM-CONDENSING PLANT.*

By Harry G. T. Oldham.

BOTH in America and Germany the cooling tower has received considerable attention; improvement has been made in its design and it is now generally an efficient apparatus. The Worthington tower consists of a number of short pieces of earthenware pipes, standing upon one another so as to break joint and to form an irregular surface to split up the circulating water and expose it to the current of air passing through the apparatus. The circulating water is delivered through a pipe at the centre of the tower, and on



BARNARD WATER-COOLING TOWERS, EDISON ELECTRIC STATION, ST. LOUIS, MO.
Wheeler Condenser & Engineering Co.

reaching the top flows into four branch pipes, from which it is sprayed over the top course of circular tiles or pipes. When reduction of weight is desired, these pipes are made of galvanized iron. The four-

* Mr. Oldham's first article on this topic appeared in *THE ENGINEERING MAGAZINE* for October, 1900.

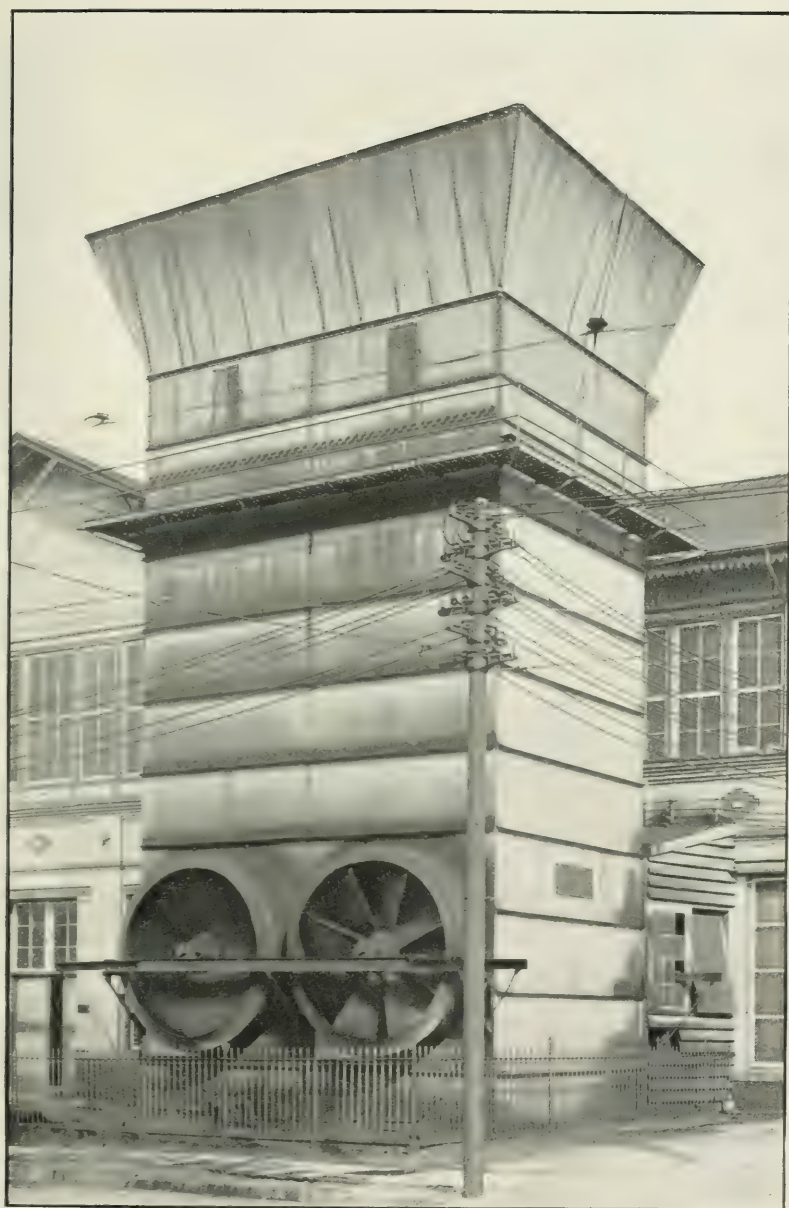
branch arm revolves on account of the impinging of the water against the enclosed air.

On the next page is shown the Barnard-Wheeler cooling tower. This apparatus contains a number of galvanized wire mats, which are hung upon hooks. These mats in some cases measure 12 feet by 16 feet, and in others 23 feet long, and are made of galvanized-steel meshed wire. The mats are hung vertically and placed closed together, so as to present a continuous surface to the circulating water and the passing air current and bring the two in close contact. On page 216 these mats are shown. Fans are used to supply the air current.

A Barnard-Wheeler tower capable of cooling the condensing water for a steam consumption of 40,000 pounds of steam per hour occupies



A WORTHINGTON WATER-COOLING PLANT.



BARNARD WATER-COOLING TOWER, 2,000 HORSE-POWER CAPACITY.
Operating at Hoboken, N. J. Wheeler Condenser & Engineering Co.



SECTION OF BARNARD-WHEELER TOWER.
SHOWING ARRANGEMENT OF MATS.

a ground space about $12\frac{1}{4}$ feet by 12 feet, by about 36 feet high. Two 10-foot diameter fans at 130 revolutions are supplied with this tower, taking about 13 horse power to drive both.

In a plant now being erected at Islington the above firm are installing their fanless tower, capable of dealing with 40,000 pounds of steam per hour. The space occupied is somewhat greater, but as no fans are used the power that would be required to drive them is saved. This type is illustrated on page 219. The tower is open to the air on all sides, and the wire mats, which are hung vertically, radiate from the centre. The water is distributed over the mats from the top of the condenser by perforated and slotted pipes.

The Klein cooling tower is usually made without artificial draught, but where space is to be economised it is fitted with air

propellers. The illustration on page 217 shows an underground cooler. The open-type Klein tower is rectangular in exterior form and contains a number of gates made of light woodwork. These are hung from each end, the next batch of gates below being hung at right angles to the ones above. The upper part of the gate forms a trough, catching the circulating water from the distributing trough, which then overflows and runs down the sides of the gate. At the lower end of the gate the water is caught by the angular points shown (which points are so arranged as to cause the water to fall directly over the trough on the lower gates), from which it overflows directly over the surface of the gate beneath.

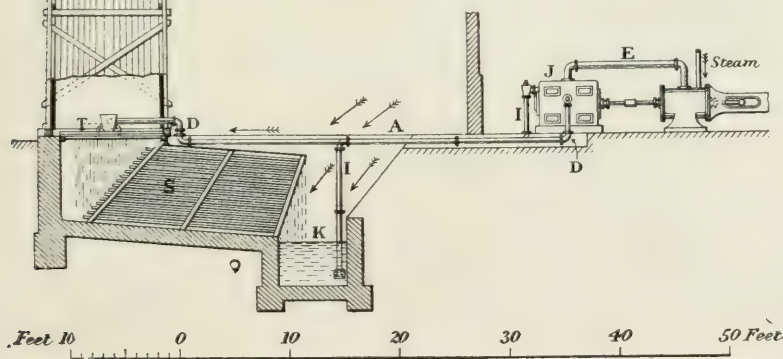
These towers are usually exposed and depend on the atmosphere to clear them of steam, but in some cases are enclosed, the air passing through them from the lowest part, as with chimney draught.

The illustration on page 218 shows an 800-horse-power Klein cooler.

The Evaporative Condenser.—It is perhaps desirable to explain briefly the principle of this type. The number of thermal units in one pound of steam at those pressures we have to deal with in the condenser are about 1,000 more than those contained in one pound of water at the same temperature. If, therefore, water be turned into steam under the same conditions, the latent heat (966.9 B. T. U.'s) passes from the steam to the water, converting the water into steam. This is exactly what happens in the evaporative condenser. The exhaust steam passes through on the inside of the tubes and the water flows on the outside, and the heat of the exhaust steam is transferred to the circulating water, evaporating a considerable portion of it. The water lost by evaporation, however, is much less than the boiler feed.

These condensers do not require cooling towers. The only auxiliaries required are an air pump and a circulating pump delivering against a head of 8 to 10 feet. In exceptional cases, where a very high vacuum is required, a cooling arrangement has been fixed below, but for a vacuum of 24 to 26 inches of mercury this is not required.

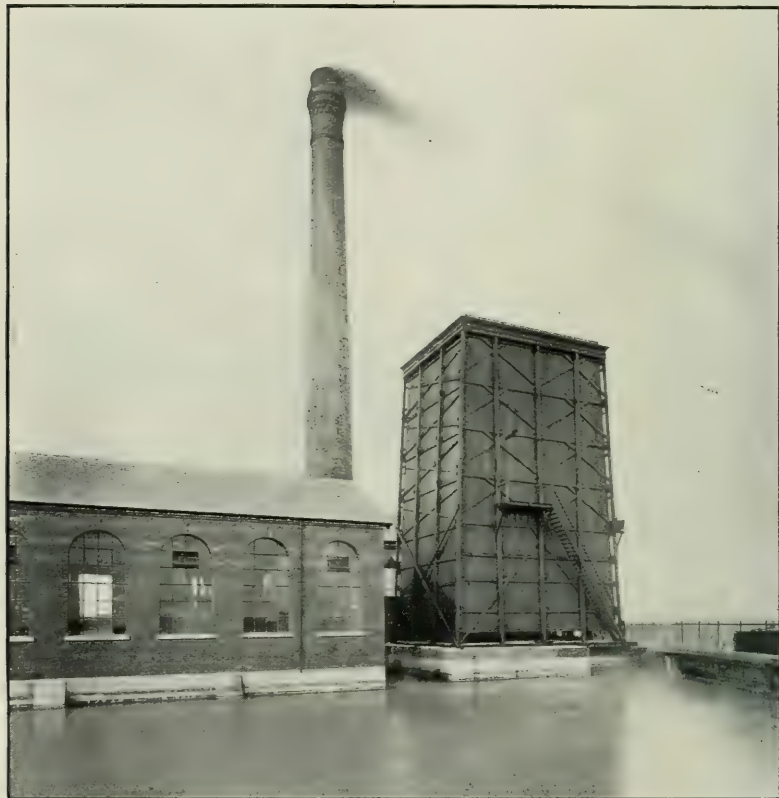
The condensers may be employed with or without a fan, and are invariably placed in the open. The space occupied is not great, and the apparatus, when better known, will be a very powerful rival to surface condensers and cooling towers. Page 220 shows a typical example of the Fraser patent evap-



JET CONDENSER AND UNDERGROUND KLEIN COOLER, WITH CHIMNEY DRAUGHT.

orative condenser, which is equal to dealing with about 200 indicated horse power. A plant recently erected by the same firm is now producing 24 inches vacuum under a load of 1,600 indicated horse power.

In this pattern of condensers the circulating water is delivered into the perforated pipes shewn, which are carried immediately above the top tube of each nest.



NATURAL-DRAUGHT CHIMNEY WATER COOLER. ILACKPOOL & FLEETWOOD TRAMROAD COMPANY'S GENERATING STATION, BISPHAM.

For cooling the condensation water from engines of 800 indicated horse power. Klein Engineering Co., Ltd.

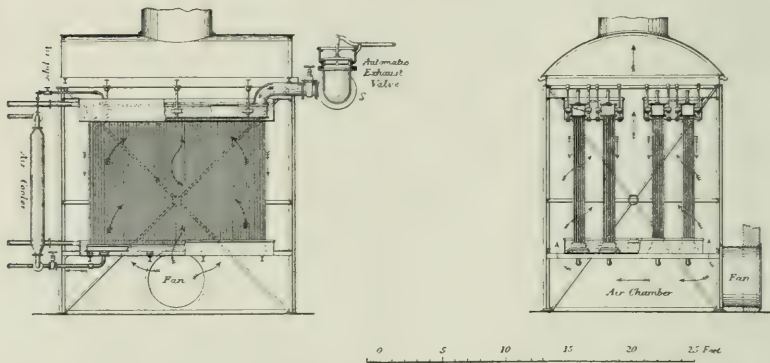
The photograph on page 219 shews a Ledward patent evaporative condenser, now working at Messrs. Sir C. Furness Westgarth & Co.'s works at Middlesbrough; it is capable of dealing with 16,000 pounds of steam per hour, or 300 indicated horse power, and maintains a vacuum from 21 inches to 22 inches, according to the weather conditions. This is accomplished without any artificial draught.



1,000 HORSE-POWER FANLESS WATER-COOLING TOWER
Wheeler Condenser & Engineering Co.



LEDWARD EVAPORATIVE CONDENSER, AT THE WORKS OF MESSRS. SIR C. FURNESS
WESTGARTH & CO, MIDDLESBROUGH.
16,000 lbs. steam per hour; maintains a vacuum of 20 to 22 inches without any artificial draught.

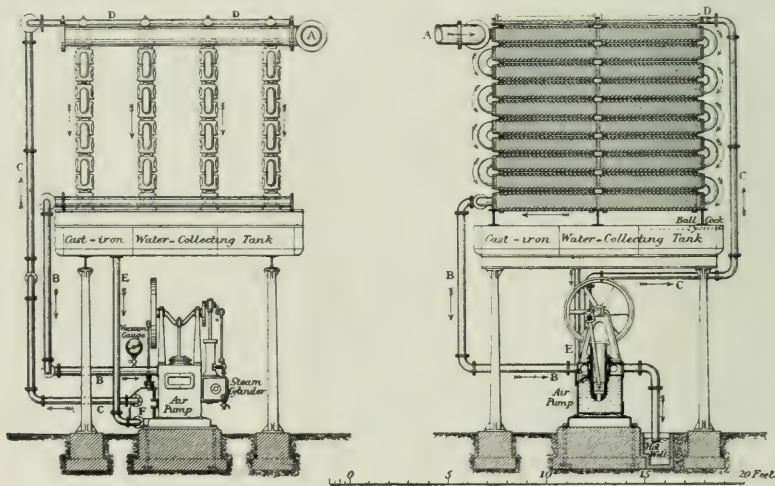


FRASER VERTICAL BRASS-TUBE TYPE OF EVAPORATIVE CONDENSER.

The engravings below shew more clearly the details of this type of condenser. The pumps are here shewn beneath the condenser, but may be placed in any convenient position. The condenser shewn is capable of dealing with about 150 indicated horse power.

It is always policy to design an apparatus so that it occupies a minimum of floor space, if this can be done without loss of economy in working. With this object in view an evaporative condenser with vertical brass tubes through which a fan was used to propel air was introduced by Thiesen in Great Britain.

Experiments have been made which shew that the condensation of steam is increased more than 50 per cent. by use of an artificial air



LEDWARD CAST-IRON CONDENSER, WITH AIR PUMP. 150 HORSE POWER.

current. How nearly this result can be approached in practice remains to be seen; undoubtedly in a carefully-designed brass-tube vertical condenser the value of a fan is considerable.

The illustrations opposite shew a section through a vertical brass-tube condenser which is representative of this type. The steam

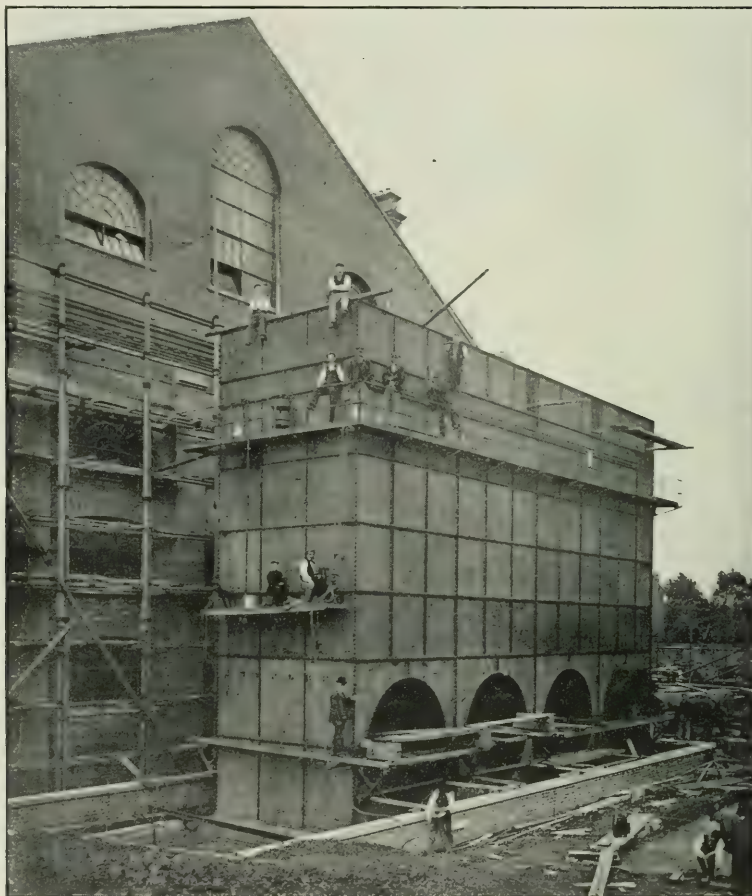


3,000 HORSE-POWER BARNARD COOLING TOWERS, EDISON ELECTRIC STATION, N. Y.
Wheeler Condenser & Engineering Co.

enters at the top and flows down the vertical tubes to the lower chamber, and is then, in the condensed form, drawn off by the air pump. The circulating water is pumped into the top tank and passes out by way of the annular spaces left between the tubes which pass through

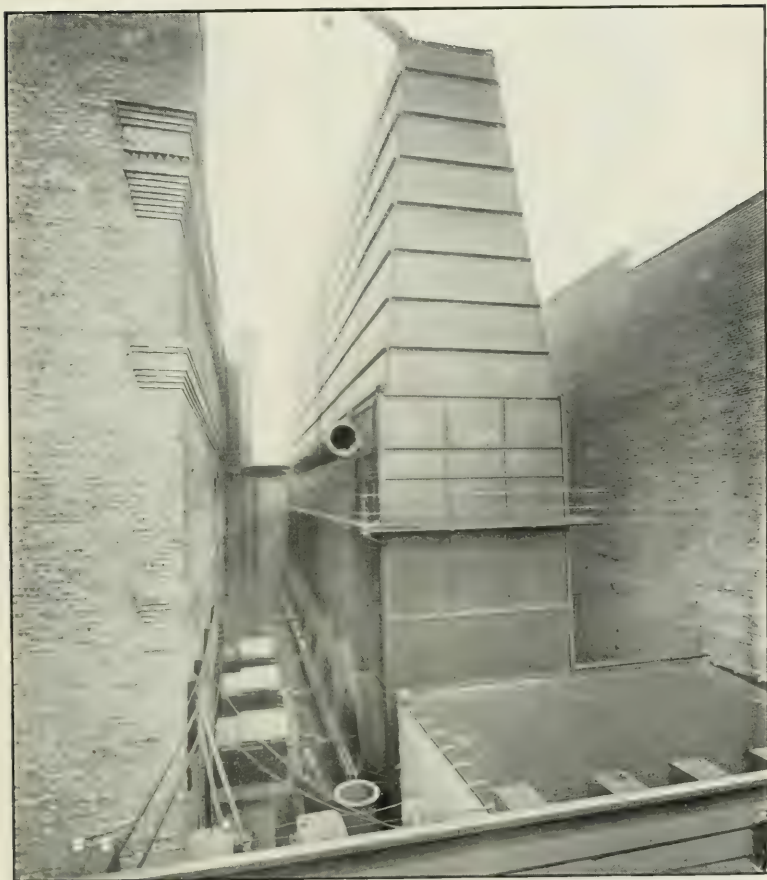
the bottom of the tank and the edge of the larger holes through which they pass. This space, however, often got obstructed with dirt, stopping the circulation of some tubes altogether.

These tubes were from 10 to 12 feet long, and difficulty was experienced in getting the water to flow evenly down the tube. Some makers wound galvanised-iron wire helically around the tubes; others lapped the tubes with galvanised-wire netting, and in some cases cups were fixed on the tubes at equal distances, to catch the water and at intervals and so redistribute. Difficulty, however, was experienced with this type of condenser from the above fact, and also from the fact that the surface allowed— 10 square feet per 20 pounds of steam per



BATTERY OF BARNARD COOLING TOWERS IN COURSE OF ERECTION, POWER STATION
OF CENTRAL LONDON RAILWAY.

Wheeler Condenser & Engineering Co.



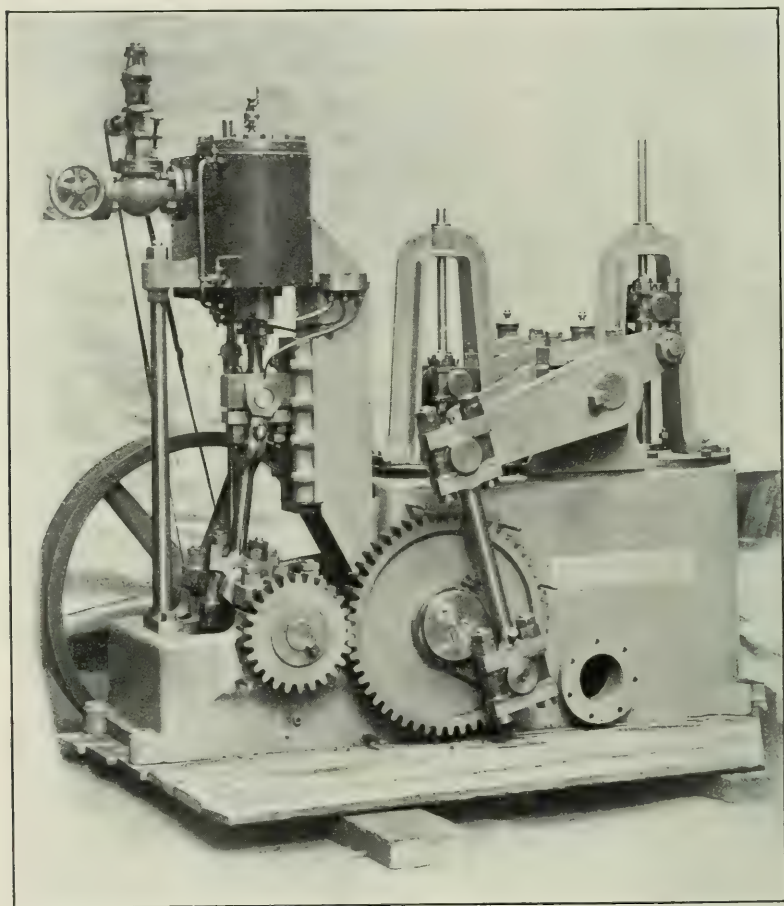
WATER COOLING TOWERS, CHICAGO, ILL. 12,000 HORSE POWER.

Wheeler Condenser & Engineering Co.

hour—was quite inadequate. The latest modern practice in evaporative condensing has evolved two types—the open horizontal-tube condenser, and the vertical type, as made by Messrs. Cooper & Greig, of Dundee. These condensers are undoubtedly giving good results.

No condensing plant can be successful unless an efficient air pump is provided. Considerable improvements have been made in this direction, and some of the leading pumps will be described. It may be mentioned that the single-acting pump with one barrel is practically discarded as regards modern condensing plants. The variation in the work upon the up and down stroke introduced conditions of wear and running that were not desirable for efficiency.

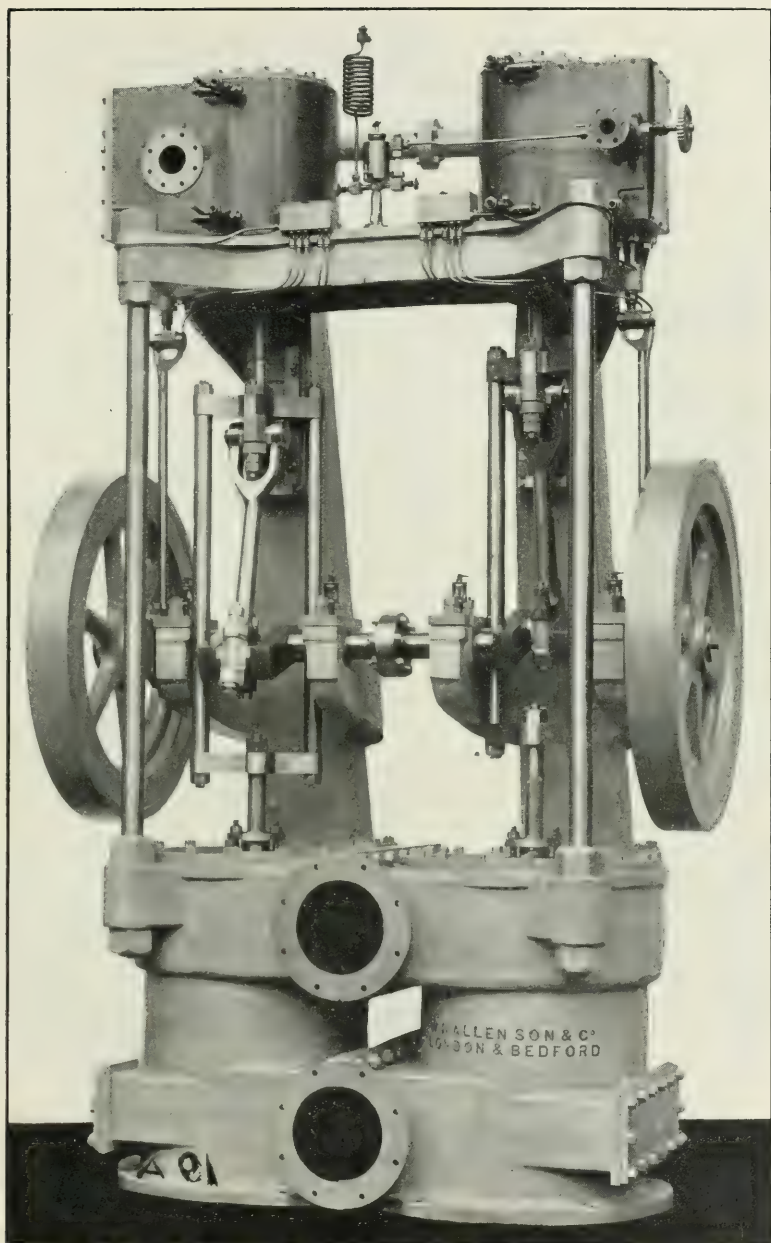
Air pumps connected directly to marine engines were necessarily of a large diameter, on account of the low velocity of the pump and bucket. It is now possible, with independently-driven air pumps, to reduce considerably these dimensions, by reason of the higher speed at which they may be run.



INDEPENDENT AIR PUMP, DRIVEN BY GEAR WHEELS AND A ROCKING SHAFT.

Messrs. John Fraser & Son.

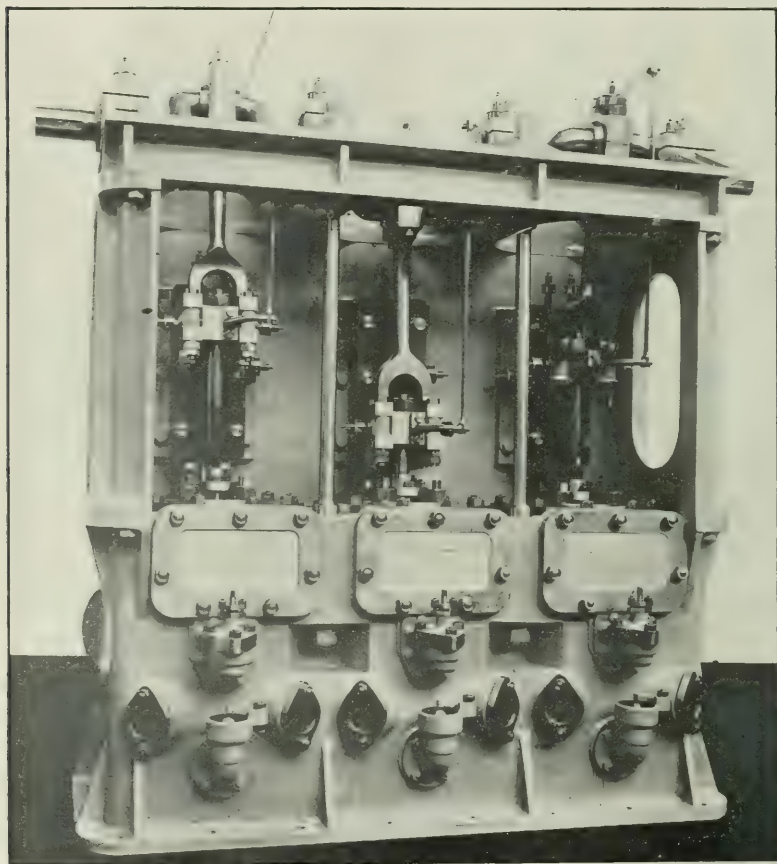
The general internal design of the air pump follows very closely that of the marine type, with sets of valves in the bucket and above and below the two extremities of the stroke. The modern air pump, however, has two or more cylinders, the buckets being driven by a rocking shaft and beam or by a 2- or 3-throw crank. An efficient air



AN INDEPENDENTLY-DRIVEN AIR PUMP.

Deals with 60,000 lbs. steam per hour: 9 and 15 by 14 inch engine. 25 $\frac{1}{2}$ by 14 twin air pumps, 90 revolutions per minute. W. H. Allen, Son & Co.

pump does away altogether with the bucket and foot valves, the only valves being those above the bucket. This type of pump admits of being run at a very much higher speed than the ordinary air pumps.



EDWARDS AIR PUMP IN CONNECTION WITH LEDWARD CONDENSER, KENSINGTON AND KNIGHTSBRIDGE ELECTRICAL SUPPLY COMPANY'S STATION.

Cylinders 12 by 12 inches; crank shaft directly-driven by 200-volt electric motor.

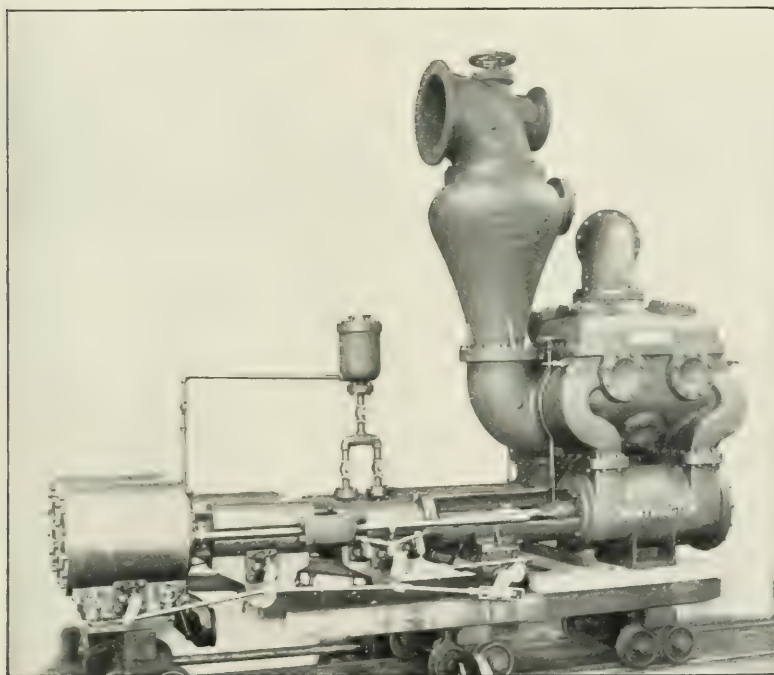
The twin air pumps shown on page 225 are by W. H. Allen & Co., of Bedford: they are capable of dealing with 60,000 pounds of steam per hour at 90 revolutions per minute. The air cylinders are 25 inches diameter by 14 inches stroke. The extreme height is 14 feet.

The type adopted by Messrs. John Fraser & Son, is shown on page 224. They are twin air pumps, steam-driven, and working through gear wheels to a rocking shaft.

The Edwards air pump shown on this page is working at the Ken-

sington and Knightsbridge Electrical Supply Co.'s Station in connection with a Ledward condenser. The cylinders are 12 inches diameter by 12 inches stroke. The crank shaft is driven directly by a series-wound 200 volt electric motor. The magnets are bolted to the pump casing, but are not here shown. On full load the power required to drive these pumps was 5 brake horse power, an extra $2\frac{1}{2}$ brake horse power being required when the pumps were first started, for extracting the air from about 6 inches vacuum before starting the engines. The maximum load was over 20,000 pounds of steam per hour.

These pumps are run in some instances as high as 375 revolutions per minute, and in pumping works as low as 20 revolutions per minute. In the former case 28 inches of vacuum was obtained with a



HORIZONTAL-TYPE AIR PUMP FOR CONDENSING PLANT.

Worthington Pumping Engine Co.

feed temperature of 107 degrees F. and the barometer standing at 30.45 inches.

The pump on this page is a Worthington air pump of the horizontal type; it is steam driven. A vertical beam type is made by the same company. The pumps described are those now generally adopted

for all types of condensing plants, and are all working in various stations and manufactories where condensers are used, as well as on shipboard.

It should not be forgotten, in regard to air pumps, that the height to which the water is raised should be as small as possible—not more than a few feet at most above the discharge valves, as this head compresses the air in the air pump. The most efficient method is to allow only 6 inches to lie above the valves—just sufficient to seal the valves effectually. To effect this an outlet is placed 6 inches above the discharge valves, the water being delivered to an adjoining tank, from which it is removed by a small plunger pump.

Oil Separators.—It is well known that oil causes mischief when allowed to pass into a steam boiler. Therefore care should be taken that adequate means are used to separate this oil from the exhaust steam. It is undoubtedly the right plan to perform this operation before the steam enters the condenser. Various methods are used to filter the feed water after it has passed through the condenser, but all depend more or less on some fibrous material or fine shavings and sawdust, through which the feed water has to be forced. When the filtering material is choked with oil it is removed and replaced, or in some cases renewed. But, as mentioned, a separator that deals with the oil before it enters the condenser is preferred. The essential points in such a separator are that it should be of ample capacity compared with the area of the exhaust pipe. The exhaust steam on entering this separator chamber expands, with a reduction in velocity, and throws down the oil held in suspension. What is not deposited in this way is caught by baffles suitably arranged on the inside.

A good method to drain this apparatus when it is a suitable height above the floor line is to carry a small pipe from the under side to a catch tank about 30 feet below the condensers; the oil then drains naturally into this tank, from which it can be pumped, and, when strained, used again. By this method 90 per cent. of the oil can be removed, and in some cases the whole appears to have been abstracted.

The subject dealt with in this article is of great import to modern steam users where even a small percentage of economy is necessary, and one that should receive the most careful consideration of every one who is responsible for the laying out of steam plants, as well as of the proprietors of existing plants; a great saving may be effected on an initial outlay which need not be great.

THE COMMERCIAL ORGANIZATION OF THE MACHINE-SHOP.

By Hugo Diemer.

VI.—THE FIGURING OF TOTAL COSTS.

THE natural basis of selling prices is the shop cost. Competitors' prices must be considered, it is true; but no matter what these prices are, the shop cost must always be a positively known quantity.

The competitive system, by the necessity of meeting the prices set by rivals, has brought about pronounced economic advantages, when reductions in selling prices have followed similar reductions in cost through the introduction of labor-saving machinery or greater simplicity in design. On the other hand, many failures have resulted from blindly meeting prices set by others before actually reducing the shop costs of machines. This has been notably the case in the history of the manufacture of electrical machinery. Some ten years ago the establishments manufacturing machines of large capacity, for street-railway power and municipal-lighting plants, demanded high prices for machines of small capacity. This opened the way for numerous small factories, which for some years were able to sell the smaller machines at prices considerably lower than the large corporations, and were able to prosper notwithstanding the admitted fact that the large corporations could not meet their prices on small machines without loss. In some cases, it is true, inferior machines were put on the market by the smaller establishments, but in many cases the lower-priced machines were efficient and well-designed. The result was that the large corporations beset themselves to re-design their smaller machines, spending large sums in experiments for the purpose of obtaining cheaper insulating materials, for reducing the weight of the more-expensive metals employed, and for winding and insulating coils by machine. The result was that three or four years ago the large

Prof. Diemer's papers began with the issue of *THE ENGINEERING MAGAZINE* for June, 1900. The preceding articles have been:

The Systematized Classification of Shop Orders.

The Production Department: Bills of Material.

The Production Department: Store-Room Management.

The Production Department: The Execution of the Work.

Practical and Accurate Time Keeping.

corporations were able to put on the market machines of lighter weight and more compactness than they had originally built, and, with improved methods of manufacture, were able to undersell the smaller manufacturers. Several of the small factories endeavored to meet the reduced prices, furnishing their heavy machines with expensive insulation and hand windings, and were unable to stand the pressure. On the other hand, other small shops have gradually worked up new designs and new methods until they are again in the field with machines practically identical with those of the large corporations, which they can afford to sell, without loss, at competitive prices.

It is apparent that during such transitional periods, a well-conducted cost-keeping system is indispensable. No progressive shop can allow the figuring of costs to drag months behind actual operations. It is necessary to know costs accurately and immediately. If the work of cost-keeping is turned over to an underpaid and overworked clerk, who has to expend all of his vitality in calculations of multiplication and addition and has no time left for comprehensive comparisons, accurate and valuable cost statistics cannot be obtained. The cost-department work is of such importance in a factory that it should receive the attention of the very best intellect obtainable. This fact has been recognized by one of the largest of American electrical corporations, the present general manager of which is a man who some years ago had charge of the cost department. And here it will be well to consider the advantage of departmental organization of clerical and accounting work, as well as of the factory proper. The cost clerk and purchasing clerk will be hampered in many ways if they are made subordinate to a book-keeper or superintendent, as is the case in many shops. A departmental separation has been found to be productive of far more accuracy, since the heads of the various departments will feel perfectly free to present matters just as they appear to them.

It is extremely important that the cost clerk or manager of cost department have time to think and to compare. In a small establishment he may be able to do a considerable amount of calculation work, such as extension of costs of material, but there are few machine-manufacturing establishments of any magnitude which would not find it a decided advantage to have available the comparative data that are obtainable if the whole time and energies of a man can be devoted to the work of intelligent arrangement and comparison of costs of individual pieces and entire machines.

In the application of the bill-of-material system, heretofore described in this series of papers, to the manufacture of electrical

machinery,* the labor costs were entered into the bill of material in the extreme right-hand column, headed "Cost of Labor," under each of the various sub-headings, such as "Armature Core," "Commutator," "Armature Coils," "Field Coils," etc., the total cost of the labor on each sub-heading in the various shop sections being entered as separate items. Thus we might have under the heading "Armature Core," the labor items "D—\$3.49" and "A—\$2.20," meaning that the work of section "D," or the punching department, amounted to \$3.49 and the labor of section "A," or the machine-shop, amounted to \$2.20 on the armature core of this machine.

After all extensions of costs of material and of labor have been entered on the bill of material, it is turned over to the manager of the cost department. If the bill-of-material system has been properly followed out, and all discrepancies in material attended to at once as soon as they were made evident by the store-room entries, there need be no delay in arriving at the total costs, the only operations necessary being the entering of labor costs and extensions of costs of material, so that complete cost bills can be had within a day, or at most two or three days, after completion of an order.

In order that material costs will be those current at date of manufacture, a small card index with a card representing each day of the month is useful for the clerk entering costs of material. On any day on which he is advised by the purchasing department of fluctuations in prices of material purchased, he makes a notation on the card representing that day, and as the bill of material shows just when material was drawn from store-room, he is able to insert the price current at time of using material.

The complete bills of material with cost entries are conveniently filed in "document file cases," a separate case being used for each order series, viz., the bills of material for "A" orders being filed in numerical succession by themselves; similarly the "B" orders, etc.

For quick reference to all machines of similar type and size, a card index should be kept, each card representing one certain type and size of machine, the order numbers being entered as machines of that particular size are completed. As there will be room on the cards for more than simply the order number, other brief entries may be made, which will frequently save reference to the complete bill. For instance, total weight, total cost, capacity, and speed, might be entered on the same line after the order number.

On receiving the complete cost-bill, the cost clerk looks up several

* THE ENGINEERING MAGAZINE, July, 1900, pages 515, 516.

similar machines on his card index, and gets the bills covering these from the document files. A careful comparison, item by item, is now made with the new bill just turned in. Any discrepancies are investigated and accounted for, and a note giving the results of the investigation is attached to the bill of material, which is now sent to the general manager, being noted by him and returned again to the cost department to be filed away.

In order to prevent delays, and to enable any bill of material to be located at any time, little record books may be kept by the cost clerk—one book for each order series—in which are noted the dates on which the bills of material are received and turned over to the various departments or clerks, the books being ruled as follows:

Order No.	Complete.	From Production Dept.	To Time Clerks.	From Time Clerks.	To Manager.	Re-turned.	Filed.
2307	10/2	10/3	10/3	10/4	10/4	10/11	10/11

The posting of labor for purposes of cost determination may be advantageously done on large sheets of good, rather heavy paper, punched at the top and kept on prong file boards. Here, as in many other instances, this method of keeping accounts has the advantage that only live orders have to be handled, since, as quickly as an order is completed, the page representing it is taken out, while in the case of a book, leaves representing dead material have to be constantly turned. Separate file boards will be used for the various order series, and the sizes of sheets used and their ruling will vary, as orders covering complete machines will require larger sheets and a greater amount of ruling than repair orders or orders for single pieces or parts.

As a basis for a price list for repair parts, it may be desirable to obtain total costs of groups of parts. For instance, in the case of a dynamo, prices may be desired for complete extra armatures, armature and field coils, individual brush-holders, journal bushings, etc. A card index may be kept for each such group of parts, a single card representing a certain size and type. Where the same individual part is used on several sizes of machines, it will be on but one card, the heading designating the sizes of machines on which it is used.

In determining the expense percentage to be added to the cost of labor as shown by the time records, the simplest process, and the one most generally used, is that of adding a uniform percentage to the cost

of labor on all classes of work. Thus, if the entire expense account of a factory, including the cost of unproductive labor, interest, insurance, depreciation, etc., is to the cost of productive labor as 150 is to 100, then one and one-half times the cost of labor on any article built in the shops will be added to its cost as shown by the bill of material and time records, in order to obtain the total cost.

This method, while simple, is objectionable because it does not differentiate articles in the manufacture of which the more inexpensive machines of a plant are employed, from articles involving the use of very expensive machinery. On the other hand, it adds a very great amount to the necessary clerical work if a definite percentage is determined for each tool and added daily to the operator's time. A compromise between these two extremes will be found in the differentiating of the output of a shop into several groups, and, by carefully examining the purchase cost and expense of operation of the tools employed in the manufacture of each group, similarly differentiating the expense percentage, so that a different per cent. will be added to the machines involving greater expense than to the group in which less expense is involved. Thus, let us suppose that the total annual cost of productive labor in a shop is \$100,000, and that the total expense, including unproductive labor, interest, insurance, depreciation, etc., amounts to \$150,000. We might determine the actual total cost of each machine now by adding one and one-half times the cost of labor as shown by the time records. But suppose we draw a line between the kinds of machines manufactured, putting all the larger and special machines in a group by themselves and all ordinary small stock machines into another group, and find now that the labor on the large machines amounted to \$50,000 and the expense item on the same machines amounted to \$100,000, while in the case of the smaller machines the labor cost amounted to \$50,000 and the expense item for this group was \$50,000. It is evident that we would cover our total annual expense item if we added twice the cost of labor as shown by the time records in the case of the large and special machines, and added once the cost of labor as shown by the time records in the case of the smaller machines. It is evident that the addition of one and one-half times the cost of labor to all machines would have been misleading, inasmuch as it would have represented the costs of the smaller machines as being higher than they actually were, and would have shown the costs of the larger machines at too low a figure. The addition of the single percentage would be quite likely to lead the management to the fallacious conclusion that they were unable to build small machines at

as low a cost as some of their competitors, who confined their efforts altogether to the smaller type, and might cause them to allow their efforts towards selling the smaller machines to flag and thus lose a line of business which would be in reality profitable.

Careful comparisons need to be made between the cost records of a shop and competitors' prices on complete machines and individual parts. The sales department should constantly be accumulating such data of competitors' prices from their bids. In all cases where it has been quite positively determined that prices have not been "cuts," and it is found that they are below what the shop can afford to quote, it is proper to investigate and see if some means cannot be found of meeting the competitors' figures. It is not a general rule that the members of a sales department are in position to ferret out for themselves the methods of meeting such competition. It is perfectly proper that the sales department should not confide its own selling prices nor those of its competitors to any other department of the shop. It is, however, of extreme importance that absolute truthfulness be observed in reporting to the technical departments the percentage by which a competitor has underbid the shop. A collection of competitors' prices may demonstrate that certain machines or lines of machines are costing the shop more than they ought to. It then becomes necessary to use every proper effort available to bring down the cost of the machine, and if the cost is cut down by legitimate means, an economic advantage has been gained not only for the shop, but, in a small way, for the trade at large. The constant reduction of prices of all manufactured commodities is by no means a sign of a demoralized condition of trade, but is a necessary essential to the world's progress. If this condition is met in a spirit of ill temper and haste, it is likely to result in business failure; but if it is taken hold of with intelligence and caution, it means success and prosperity to the manufacturer.

THE GENERAL PRINCIPLES OF SUCCESSFUL MINE MANAGEMENT.

By A. G. Charleton.

IT may seem almost self-evident that one of the secrets in conducting mining operations so as to secure a maximum of profit—the point naturally to be aimed at—is to get the largest amount of work that is possible out of each man employed, without “sweating” him but at the same time without overpaying him; and to secure the most useful effect that can be got out of the various machines in use, up to the full limit of their capacity, in the shortest possible time, without overtaxing them; that is to say, speaking generally, it depends on making the best use possible of the men and materials, placed by circumstances at the disposal of the manager of a mine.

Obvious as this proposition may appear in principle, however, it is apparently by no means always recognised, or acted upon in practice, or there would be fewer mining failures; whilst company's profits would often be increased in cases where profit may, to some extent, perhaps, be already earned.

Managers, indeed, often seem to fail to grasp the fact that the value, whether of men or machines, is the profit translated into money which their work represents when spread over a given period of time; consequently, the net profit or loss resulting from the undertaking is the difference between what I may term the “profitable and unprofitable units of work” accomplished in the aggregate.

If the former exceed the latter the business as a whole must necessarily be profitable, and *vice versa*; but it is often the case that individual carelessness or departmental inefficiency may reduce, if not entirely wipe out, profits actually earned in other directions, in which work has been executed with greater relative economy.

The various and complex factors determining the success or failure

The modern era of mining, which has witnessed developments so enormous in South Africa, Australia, and the United States, has its source, first in the perfection of engineering methods which have reduced exploitation and mine surveying to an exact science, but scarcely less in the realisation that mining is not a gaming venture but a legitimate productive occupation, to be managed carefully, economically, and watchfully if success is to be attained.

The principles of management are akin to those actuating the direction of any industrial undertaking, but their adaptation is special to the field and as wide as its varied demands and opportunities. Mr. Charleton, in this issue, begins a treatment of the subject which will develop as great a range and as keen an interest as did the recent articles on shop management, appearing in this magazine.—THE EDITORS.

of any particular mining enterprise may be classed under two distinct heads:

(A) Uncontrollable, depending on the intrinsic value of the property itself, and its natural environment;

(B) Controllable, that is to say, dependent upon the efficiency of its general management.

The latter subject alone falls within the scope of this article.

Broadly speaking in this latter connection, I think it may be said that the measure of success attained in mine management depends upon the amount of judgment exercised:

(1) In the selection of the most suitable machinery and materials to effect various specific purposes.

(2) In the choice of men selected to perform any requisite piece of work, and in the way in which they are handled.

(3) In the employment of men and machinery collectively, in the execution of different jobs, so as to secure the best possible results at the least possible cost.

In addition to these primary requirements, however, tactfulness in dealing with people with whom a manager is brought into contact, whether in the position of directors, outside business-people, or subordinates, is a branch of his multitudinous duties second only in importance to resourcefulness in utilising the materials at his command, and in dealing with emergencies calling for prompt action. Above all, it is essential that he should possess that combination of practical, scientific, and business knowledge necessary for a mining-engineer to take full advantage of any improvements in technical practice, which will save labour, improve extraction, enlarge output, or otherwise cheapen production; finally, he should see that he is in a position to ascertain at a moment's notice exactly what is going on in every department of work which is not immediately under his own eye.

To consider all these matters in detail, I need scarcely say, would fill a library, and I will only glance briefly at the first three points I have alluded to, concentrating most attention, in the space at my disposal, upon the subject of "organisation"—a faculty which, when properly turned to account and applied, supplies a manager with a thousand eyes in place of a single pair, besides enabling him to unravel the commercial problems that the workman, or even the foreman in charge of a piece of work, knows nothing about, viz., the profit or loss which should result, or has resulted, in the execution of any particular job. It thereby guides him in shaping his policy to the best advantage to suit the circumstances he has to deal with. In a word, it places

him in a position to "boss the show," on proper business-lines, through knowing what he is talking about, what he wants, and what ought to be done, to insure a certain result. This is the position he should occupy, in place of being at the mercy of his subordinates.

It is this particular class of knowledge that differentiates a capable manager from others who, notwithstanding equal or even better opportunities, seem to have been born with a monocle and cannot always use even that to any appreciable advantage.

It is this faculty of "organisation," assisted by education, experience, and observation, cultivated by scientific training, as I shall endeavour to show presently, which enables a manager when underground, or when moving about the works, to use his eyes to a hundred times better advantage, however sharp he may be in noting all that comes within his own range of vision.

The danger to be avoided in this connection—which some managers insensibly fall into, however—is that of running to one of two extremes: either spending too much time in the "office," or too much time underground and about the works; in fact, it is a matter of the greatest importance for a mine manager to economise and lay out to the best advantage his own time, as well as that of other people, bearing in mind that he requires not only to see for himself what is actually going on, but to study its commercial results at his leisure; otherwise, without knowing the exact nature and quality of the work executed, he can never properly gauge its value in relationship to its cost.

The absurd idea that a manager should be as handy in "beating a drill" as the miner who is daily and solely employed in that operation is a relic of mediæval simplicity, although not entirely extinct, its embodiment being found in the demand that one still sometimes hears, for a so-called "practical" mine-manager. It is equally irrational to expect that a manager will be able to turn out assays or run survey-lines with the facility a man constantly engaged in such work can attain to; it is sufficient that he has had practical training in these various departments and is consequently acquainted with what others should do and are capable of doing.

To sum up: what is wanted for efficient mine management is the happy combination of general experience, engineering knowledge, and business capacity, regulated by administrative ability. A man may be, in fact, a first-rate engineer but a second-rate administrator, or the converse, and fail in either case where other managers with less ability in some one of these departments alone succeed. And in conclusion, if I may venture to give a piece of advice to the younger members of

the profession, it is this: neither lose time in tackling work that has to be done, nor attempt to rush things too rapidly (I mean in the sense of prematurely), and as the *raison d'être* of the engineer is to overcome difficulties—he is not intended for an easy life—try to find some means to get over them; but when you happen to be in a difficult corner, follow Baden-Powell's advice: "sit tight," and stick to it until you succeed.

The Selection of Machinery and Materials.—To be able to place his hand on the proper article or piece of machinery for a particular job is an art which, as everyone who has tried it knows, is not to be acquired from makers' catalogues alone and cannot be learned in a day; in fact, it is only to be learned by experience, involving, as it does, a more or less thorough acquaintance with the relative merits, capacity, durability, price, and applicability of mechanical appliances of all kinds employed in mining operations. The chief point to be determined is whether quality and design shall be sacrificed to price, or whether it is cheaper to pay a higher price for a better article, the choice depending partly on the time any particular piece of machinery is likely to be required to last, partly upon its comparative suitability for the purpose for which it is to be employed.

How to choose the right man for the work to be done is a matter perhaps even more difficult than the selection of the proper material, if, as often happens with a shifting population like that of a mining camp, the personal equation of value is a comparatively unknown quantity at the moment choice has to be made. It is an art some managers seem to acquire more or less instinctively, whilst others master it with difficulty and many never do so at all. They get fooled by men they employ so often, and so thoroughly, that one really wonders whether they go wrong from choice, or from what my many American friends aptly call "cussedness." Needless to say there is no golden rule to go by nor golden road to knowledge of this class; it comes to those who seek it simply by experience of men and nothing more—bar their looks, and these may sometimes prove deceptive; but when you have found a good man, never lose sight of him, advance him if you can, and remember that his value is not measured by the wage you pay him so much as by the quantity and quality of the work he accomplishes. So-called "cheap men," like cheap materials, often prove the most expensive in the long run.

In dealing with his men, two things a manager should most carefully avoid are favoritism and undue familiarity; instead of condescending to his popularity these are sure to create jealousy and destroy the con-

fidence and respect the manager of a mine needs to handle a large body of workmen successfully. The worst possible mistake some managers make is to select a man simply because he happens to be a relation or fellow-countryman, or for some other personal reason; the only test that should govern advancement ought to be well-trying individual relative merit.

Mutual confidence between employer and employed, loyalty, *esprit de corps*, and discipline are likewise factors of great importance in running a mine successfully. A manager, if he is wise, will depend on his own judgment, discourage tale-bearing, and listen to no reports from his subordinates regarding their fellow-workmen or "shift-bosses," as he ought to be able to ascertain whether work is being carried out satisfactorily or not, and repose confidence in those under him until he finds it abused, giving each man a fair trial, and being careful to avoid jumping at over-hasty conclusions.

Loyalty to his immediate chief is owed by the miner or mill-hand to his shift-boss, and by the shift-boss to the mine-captain or mill foreman, in the same degree as these departmental officials owe loyalty to the manager or superintendent, and he, in his turn, owes it to his directors, who represent the shareholders in the concern. When loyalty is lacking, things generally go badly for everybody. Loyalty is a better force than fear of discharge in preventing miners from giving information about a mine which they have no right to do, before it is communicated to the head office, of which shareholders so often complain. Still more important is the *esprit de corps* of a body of men who are proud of their mine, take pride in their work, and work together to make it a success—which will often largely help to save an undertaking from failure.

To cultivate this spirit, whilst strictly enforcing discipline, is a matter to which every mine manager should devote attention. And whilst it is more or less an obligation he owes to his men, generally speaking, it will well repay him to take an interest in their comfort and well-being. By looking after their safety, starting cricket and other clubs, and encouraging them to improve themselves in their leisure (if they care to take advantage of it), a manager can show his friendship for those under his charge in a manner which they can appreciate, and the result tends to promote the well-being of the whole concern.

In fact, it is practically certain that if you want to get the best possible value out of men, the way to do so is to pay them well, treat them impartially, keep them in health with exercise, and train and educate them as far as they can go with advantage to themselves, this latter

factor depending, of course, on the amount of brain, industry, and ambition that each individually possesses; and although opinions may perhaps differ on the subject, my own experience is that one can get more profitable effect out of a body of miners, with six days' honest hard work on 8-hour shifts, spurring them to effort through taking pride in what they do, than by any amount of "bullock-driving" in seven days. Where seven days' work is necessary, limit it as far as possible to repairs and certain work which must be kept going.

The employment of men and machinery collectively in the execution of different jobs, so as to secure the best possible results at a minimum cost, calls for practical experience in mining, metallurgical, mechanical, hydraulic, electrical, and other dynamical questions, demanding a more-or-less thorough general knowledge of strength of materials, the design of structures, types of machinery, and the adjustment and operation of various machines.

In cases of sufficient importance, questions of this kind are frequently, however, entrusted to a "specialist," a course which it is always wise to adopt unless the manager happens to be specially posted in the subject. A superintendent who is "jack-of-all-trades," like the handy man who professes to know everything, is usually a failure.

Amongst the subjects most frequently falling within this particular branch of a manager's duties might be mentioned:

1. The organisation of the actual underground mining work, which is greatly facilitated by a careful study of the geological and mineralogical character of the ore-deposit itself, neighbouring mines, and the geology of the surrounding district.

2. The installation of the most suitable mechanical appliances, aided by manual skill, with a view to secure the rapid development, cheap extraction, and convenient transport of the ore, in addition to the removal of water and the lighting and ventilation of the mine workings; as well as means to obtain proper access to the various working-places.

3. Supervising the preparation of general designs and plans for the internal arrangements of surface buildings and reduction works, so as to reduce working costs by economising and facilitating labour. This matter frequently depends to some extent upon the sites selected when laying out the works, in respect of the advantages they offer for the delivery of ore, fuel, and fluxes, for securing an adequate water-supply, and for the disposition of tailings or other products, whilst permitting the best arrangement of machinery.

4. The adaptation and application of the process selected to the

extraction of the metal sought, so as to obtain it at a minimum cost, and to prevent loss of valuable mineral.

These and kindred questions are matters which a manager has frequently to settle, although some of them may already have been decided for him by his predecessors in office and in consequence be beyond the range of his control. It is therefore, as a rule, a great advantage to have a free hand in the original laying-out of the mining work and plant.

In the organisation of the work under his charge, my own view is that the manager should endeavour to trust as much as he can, without trusting too much, to the various heads of departments acting under him—stimulating them to use their brains and exercise independent judgment when occasion calls for it, and to look to him for advice only when in doubt or difficulties. That is to say: having given a foreman general instructions, I always make it a rule myself never to interfere with the way in which he carries them out, if it can be avoided, but to hold him responsible for its proper execution.

Matters which specially fall, however, within the province of the manager to attend to personally, and on which he should particularly post himself are :

1. The mining laws and regulations of the district in which the property is located, the past history of its mines, and the progress of their development.

2. Local labour problems, which influence questions of management, such as hours of work, wages, and an adequate supply of efficient labour: the avoidance, so far as possible, of giving needless occasion for disputes with labour-organisations by ill-advised action: seeing also that any funds set apart for the benefit of the workmen are properly administered.

3. The general mining and surface-work going on, to be ascertained by personal examination and by studying the reports that should be submitted periodically by the various heads of departments.

4. The developments in progress and the "reserves of ore" opened up, which should be shown on an "assay-plan" and personally checked from time to time.

5. The cost of every branch of work, as governed by the way it is laid out, output of ore, price and quality of materials used, and the wages and efficiency of the workmen engaged upon it—all of which should receive constant attention.

6. Matters of general business involved in carrying on local correspondence, telegrams on various subjects, letters, cables, and reports to

the head office, checking the general-accounts, stores-invoices, reports of heads of departments, and receipts and expenditures; besides watching "exchange" when called upon so to do, and making proper provision for meeting current expenses, outstanding indebtedness, and future liabilities.

7. The drawings and plans for the erection or alteration of machinery, buildings, etc., mine-surveys, and assay-plans.

8. The terms of all contracts, specifications, and tenders, so that work may be executed properly and at the lowest possible rate.

A manager who attends to these matters properly will not find time hang heavy on his hands, and he will deserve whatever holidays he can get, even given a thoroughly efficient staff, without which it is of course impossible to conduct the business of any mine properly.

I use the term "manager," however, advisedly in the above connection, as these duties, or some of them, are at times undertaken by a local consulting engineer in charge of a group of mines, when one property by itself is not of sufficient size and importance to need or afford the exclusive services of a highly-paid manager. At other times, some portion of them may be entrusted to a local board of directors, acting under the advice of a consulting engineer, as is frequently done on the Rand.

In the case of a property in an isolated position, and not in a large mining centre like Johannesburg, such an arrangement is not, however, always feasible, even supposing it to be desirable; and a manager may be called upon to supervise all or most of the matters I have mentioned entirely himself. But if the mine is a large one, the commercial part of the business may be placed in charge of a business-manager, or commercial-superintendent, who should, however, act under the instructions of the general manager or consulting engineer as the case may be, and not as an independent official; otherwise a company is certain to suffer from the troubles which invariably arise from dual managership; one responsible head is an essential, in my opinion, for the proper conduct of business of any description.

Whether the business is divided up for the sake of convenience, or not, makes little difference as regards the actual scope of a manager's responsibilities, for the direct supervision of the details in each department must in any event be left to his staff, and his business is chiefly to see that their immediate duties are properly carried out.

The staff under the general manager in exceptional cases may consist of a business-manager, an assistant manager, metallurgist, assayer, mine-surveyor, mechanical engineer, mine-foreman, mill-foreman, sur-

face-foreman, accountant and cashier, wages-clerk, and store-keeper; but in small concerns the duties of several such officials would naturally be merged into one, whilst special cases may demand putting on a special man to supervise some particular branch of work.

No fixed rule can be laid down as to the amount of supervision necessary, except the general principle that all work on which a sufficient number of men are employed requires effective direct control, and the amount each head of a department can supervise depends on how much there is to look after and how much he can properly attend to in the time at his disposal. This may vary from a 12-hour, to more-or-less of a 24-hour day, the manager not unfrequently being called upon to make a round on night shift.

Next to labour, economy in the use of explosives and timber underground, and fuel and water on surface, are the chief factors which determine the cost of mining operations. The storage and handling of explosives, so as to avoid accidents, facilitate their distribution, and prevent theft, and the character and quality of the explosives used, and the system adopted in using them, so as to secure the best results, should therefore receive the manager's personal attention.

Where rock-drills are employed, a manager has therefore to consider a number of points that bear on this subject: the best type of machine to use, the machinery employed for the supply of air and its distribution to the working-places, the handling and care of the machines underground, and the way of applying the explosive selected. Records of this work must of course be adapted to suit each case, but in the best-regulated mines particulars of shaft-sinking should be tabulated for reference—the total number of rounds drilled, the average, as well as the longest and shortest, time occupied in “drilling” each round, the average time taken in cleaning up, the longest, shortest, and average time taken in drilling and cleaning up, the average depth sunk per round, the total depth sunk per month, and the depth and position of holes in each round, shown diagrammatically. In addition, details of the quantity of explosives consumed and the time taken in the various separate operations of drilling, charging and firing, and cleaning up are occasionally called for.

In “driving” again, whether “speed,” or “price per foot,” is the main object, it is frequently desirable to ascertain and tabulate the results, with a view, if possible, to “beat the last record.”

The support and timbering of working-places in a safe and economical manner is another important matter to look into, upon which much might be said, but space only permits me to refer the subjoined

list of authorities. The seasoning and preservation of timber are also subjects that will often repay looking into.

Underground haulage and storage of ore, pumps, ventilation, and hoisting machinery require to be looked after, whilst frequent visits to the shops, magazines, stores, mill, or other surface works. I need scarcely say, claim no inconsiderable part of a manager's time.

Beyond all this, a manager requires to see that developments are pushed ahead on systematic and proper lines; not, as is too frequently the case, in a haphazard "where it is, there it is" fashion, but with a definite object in view, based on a sound interpretation of the geological evidence at his disposal. He should make sure that the stopes are carried to the right width and laid out properly, and that due attention is paid to sorting out waste, if necessary; and he should satisfy himself that proper checks are kept on the quantities of ore won or trammed from different sections of the vein or deposit, and of the value of the lode, where it is being opened up.

To check quantities of ore delivered, as ascertained by keeping a proper system of "tallies," underground and on surface, the manager should see that the "stopes" are properly and regularly measured up by the mine surveyor. To see that a proper assay-plan is constructed and kept up to date should be one of the chief matters to which a manager should devote care, bearing in mind the fact that the value of assays depends entirely on the accuracy of the sampling.

On the surface, the storage, conveyance, sorting, crushing and treatment of the ore need attention, and the records of a mill, cyanide works, or smelter require to be so kept as to show the quantity and value of ore treated, percentage of extraction and tailings-assay, labour, fuel, water, fluxes, supplies, etc., used, and the value and amount of the resulting products; the manager making it a special point to assure himself that no gold is being stolen from the mine itself, and that returns of amalgam and bullion are properly checked, by being always present, if possible, when there is a "clean-up."

Of course to control effectively work constantly going on, a manager should be more or less thoroughly acquainted with such subjects as applied mechanics and machine-shop practice, blacksmith's work, carpentry, and the design of structures. Photography, first aid to the injured, and a knowledge of the proper treatment in ordinary cases of illness, although scarcely falling within the scope of his duties, are at times also very useful subjects to know something about.

It is a part of his duties to see that the assay department and bullion department (if the property is a gold mine), are properly organ-

ised, cordwood is regularly measured up, stock is taken of stores, invoices are compared with goods delivered, and that regular reports are made by the mechanical engineer or whoever is immediately responsible, upon the condition of the machinery in different departments, showing that boilers have been tested and cleaned when necessary, their individual consumption of fuel and water ascertained and recorded, and that diagrams have been taken of the engines used for winding, pumping, air-compressing, and driving mill machinery. Revolution-counters may be attached with advantage to such engines as air compressors, operating under variable loads, whilst pumps or pumping engines should have a card kept close by, on which is noted daily time of starting and stopping, number of strokes, etc. A manager should satisfy himself that renewals and repairs are properly looked after, and charged up; more especially that winding-ropes and signalling and safety-appliances are regularly and thoroughly inspected, and that a record is kept of the life of the different wearing parts of the machinery.

The limits of an article of this kind might, however, be indefinitely extended, if I attempted to deal with all the subjects a mine manager may at times be called upon to take in hand and supervise. I have only named those that are of most importance to call attention to, indicating where information respecting most of them can be obtained, so far as it can be learnt from books. In a following article I shall take up, with the aid of forms and record blanks, the office work, and especially the very important matter of accounting, book-keeping, cost-keeping, the classification of expenses, and the making up of statements.

The following works will be found of service and value in the specialised treatment of the several branches of mine management indicated by their titles:

Ore and Stone Mining; C. Le Neve Foster. Chas. Griffin & Co., London.

A Handbook of Gold Milling; Henry Louis. Macmillan & Co., London and New York.

Treatment of Gold Ores; Wm. McDermott and P. W. Duffield. E. & F. N. Spon, London.

Stamp Milling of Gold Ores; T. A. Rickard. The Scientific Publishing Company, London and New York.

The Choice of Coarse and Fine Crushing Machinery and Processes of Ore Treatment; A. G. Charleton. Trans. Federated Inst. of Mining Engineers.

Hints on Amalgamation and the Care of Gold Mills; W. J. Adams. Modern Machinery Publishing Company, Chicago.

California Gold Mill Practice; C. B. Preston. Bulletin No. 6, the California State Mining Bureau.

Gold Mills of the Rand; Dr. F. Hatch and J. A. Chalmers. Macmillan & Co., London and New York.

Chlorination, Concentration, etc., treated of in articles by John Rothwell, Prof. Richards, and others in the Mineral Industry. The Scientific Publishing Co., New York and London.

The Witwatersrand Gold Fields; S. J. Truscott. Macmillan & Co., London and New York.

Practical Notes on the Cyanide Process; F. S. Bosqui. The Scientific Publishing Co., London and New York.

Present Day Metallurgical Engineering on the Rand; John Yates. London Mining Journal.

The Cyanide Process; Dr. A. Scheidel. Bulletin No. 5, The California State Mining Bureau.

Papers by Alfred James, M. Eissler, and others; Transactions of the Institute of Mining and Metallurgy.

Cyanide Plant and Accessories; the Cyanide Plant Supply Company, London.

Catalogue, 1899, Bromo-Cyanide; the Gold-Ore Treatment Company, Ltd., London.

Matte Smelting; H. Lang. The Scientific Publishing Co., London and New York.

The Lixiviation of Silver Ores with Hyposulphite Solutions. The Scientific Publishing Company.

Modern Copper Smelting, 7th Edition; Dr. E. D. Peters. The Scientific Publishing Co.

Lead and Copper Smelting; H. W. Hixon. The Scientific Publishing Co.

The Metallurgy of Lead, 5th Edition; H. C. Hofman. The Scientific Publishing Co.

The Metallurgy of Lead; H. F. Collins. Chas. Griffin & Co., London.

A Text Book of Assaying; C. and J. Beringer. Chas. Griffin & Co., London.

A Hand Book of Modern Explosives; M. Eissler. Crosby, Lockwood & Sons.

The Blasting of Rock; A. W. and Z. W. Daw. E. & F. N. Spon, London.

Mitchell's Manual of Practical Assaying.

A Text Book of Plane Surveying; W. G. Raymond. The American Book Co.

Treatise on Mine Surveying; B. H. Brough. Chas. Griffin & Co., London.

Mine Drainage; S. Mitchell. Crosby, Lockwood & Co.

Mine Drainage, Pumps, etc.; Hans Behr. Bulletin No. 9, California State Mining Bureau.

Cornish Mine Drainage; S. Mitchell and J. T. Letcher, 43d Annual Report Royal Cornwall Polytechnic Society.

Care of Wire Rope; J. Shakespeare. Report of the Secretary of Mines, Queensland, 1894.

The Practical Steam Engineer's Guide; E. Edwards. H. C. Baird & Co.

Steam and the Steam Engine; Dr. Evers. W. Collins & Co.

Gas, Air and Oil Engines; B. Donkin. Chas. Griffin & Co., London.

Dynamo Electric Machinery; Silvanus P. Thomson.

Electric-Power Transmission; Dr. Louis Bell.

Mine Timbering; W. H. Storms. Bulletin No. 2, California State Mining Bureau.

Report Book for Mining Engineers; A. G. Charleton Whitehead. Morris & Co., London.

Lock's Miners' Pocket Book. E. & F. N. Spon, London.

Practical Engineers' Hand Book; W. S. Hutton. Crosby, Lockwood & Co.

The Works' Manager's Handbook. Ibid.

Estimating and Sampling Ore Reserves; W. Wybergh. Trans. Inst. Mining and Metallurgy, London. Vol. IV., 1895-6.

Graphic Assay Plans; W. Wybergh. Ibid, Vol. V. 1896-7.

A Graphic Method of Estimating Ore Reserves; A. G. Charleton. Ibid, Vol. IX, 1900-1901.

Observations on Sampling, etc.; G. A. Denny. Trans. Inst. Mining Engineers, Newcastle-on-Tyne, 1900.

Mine Sampling; W. McDermott. Trans. Inst. Mining and Metallurgy, London.

Very useful information may be derived also from the catalogues of makers of mining machinery, as, for example: Fraser & Chalmers, Ltd., and the Gates Iron Works, London and Chicago; the Union Iron Works, Risdon Iron Works, and Park & Lacy, San Francisco; the Sandycroft Foundry, Chester, England; Appleby & Co., London; Chester & Co., Renfrew, Scotland; the Rand Drill Co. and Ingersoll Sergeant Drill Co., New York and London; California Wire Works, San Francisco; Bullivant & Co., London; Bullock Mfg. Co., Chicago; Messrs. Islers, London; the Trenton Iron Co., Trenton, N. J.; Sullivan Machinery Co., New York and Chicago; the Bucyrus Co., South Milwaukee, Wis.; Marion Steam Shovel Co., Marion, Ohio; the Vulcan Iron Works, Toledo, Ohio; the Jeffrey Mfg. Co., Columbus, Ohio; the Diamond Coal-Cutter Co., Messrs. Ernest-Scott and Mountain, and the leading manufacturers of machinery everywhere whose advertisements may be found in the technical periodicals.

THE LOCOMOTIVE EXHIBIT AT THE PARIS EXHIBITION.

By Charles Rous-Marten.

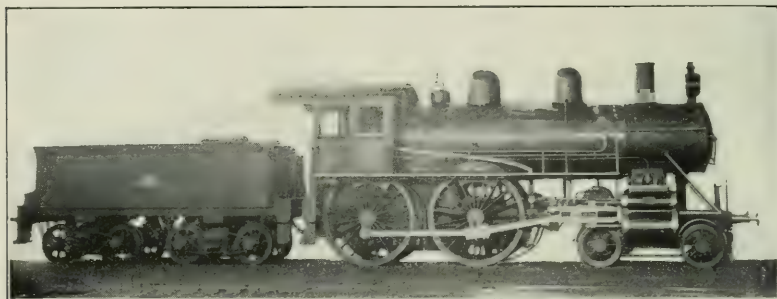
PURSUING my idea that the salient principle of the Exposition of 1900, so far as locomotives are concerned, is *increased haulage power*, I come next to the special method of attaining that end, which the present Exposition has brought to the front in so remarkable a degree. I mean the development of compounding.

I have already said that, outside of the British section, by far the larger number of engines are constructed on one or another of the numerous compound systems which are now on their trial in Europe and America, some of which, indeed, have virtually passed the stage of trial and have become accomplished facts and recognised successes. It forms no part of my present programme to appraise their relative and proportional popularity. But in view of the fact that every leading railway in France is represented, as are also certain German and Swiss lines, by one locomotive or several, all constructed on one particular system of compounding, however much they may differ in general design or in details, I think I am warranted in according a certain prominence to that system. It is the one invented by Mons. A. G. de Glehn, director-general of the Société Alsacienne de Construction Mécaniques, which has such vast workshops at Belfort and Mulhausen, *i. e.*, respectively on the French and German sides of the Alsacian frontier of France and Germany.

In my article on the locomotive work of the Northern Railway of France, published in *THE ENGINEERING MAGAZINE* of February, last year, pp. 784-798, I gave a general description of the de Glehn compounds as designed by Monsieur du Bousquet, ingénieur en chef, and built for that line. Since that date, that is to say, during the years 1899 and 1900, engines of various designs, in which this system of compounding is employed, have gradually taken possession of all the French main lines. On the Midi, Etat, and P. L. M. railways, indeed, they were to be found even prior to 1899, but they now perform the most important passenger services also on the Orléans, Est, and Ouest lines. More than 800 locomotives constructed on this system are now at work on the European continent.

Mr. Rous-Marten's first article on this subject appeared in *THE ENGINEERING MAGAZINE* for September.

The Chemin de Fer de l'Etat, or State Railway of France, has, however, recently placed on its road four express engines of the four-cylinder compound type, but of a different design, viz., the Vaucelain, which is so largely in use on the American continent. These engines were built by Messrs. Burnham, Williams & Co. at the Baldwin works, Philadelphia, and one named "Montlieu" is to be seen at Vin-

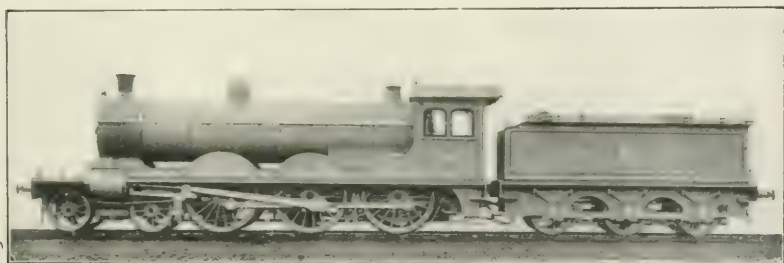


THE MONTLIEU, VAUCLAINE COMPOUND. BUILT AT THE BALDWIN WORKS, PHILADELPHIA, FOR THE STATE RAILWAY OF FRANCE.

cennes. The Vaucelain system differs from the de Glehn mainly in having all its four cylinders placed outside the frames, the high-pressure being superposed above the low-pressure, and in the two piston rods on either side driving on to one cross-head, whence the connecting rod propels the rear pair of coupled wheels. Thus all the four cylinders drive the same axle and pair of wheels, as in the case of the Webb compound "La France," but in the latter case the two high-pressure cylinders are outside and the two low-pressure cylinders inside, as in the de Glehn system, in which, however, each pair of cylinders drives a different axle. The use of a single axle for the transmission of the whole propulsive power of the locomotive is to be found also in the four-cylinder tandem compounds, of which several instances are to be met with at Vincennes, and in the two-cylinder systems of Mallet and von Borries. Theoretically, no doubt, the heavy strain placed on a single axle by subjecting it to the pull of four cylinders is undesirable. When two cylinders are inside and two outside, as in the Webb engine, the axle has all the disadvantages which attach to those of outside cylinder engines on the one hand, and of inside cylinder ones on the other. That is to say, it unites all the drawbacks which theoretically are associated with straight axles and cranked axles respectively. The essential inherent weakness in shape of the cranked axle, regarded as a column, needs no demonstration at all. But it has been claimed—and experience seems to support the claim—that this weakness has virtually been overcome by improved methods of con-

struction, such as the "building-up" plan which is employed, I believe, both on the London & North Western and the Midland lines, or the circular web device adopted by the North Eastern. Personally, I am disposed to think that, with modern excellence of design and construction, such as is found in Great Britain and France, to which countries the use of cranked axles is almost exclusively confined, there is very little to choose between the two kinds in respect of safety and efficiency. In America and throughout the greater part of the European continent the cranked axle is, I believe, almost, if not wholly non-existent, excepting in the case of those designs of four-cylinder compounds in which two of the cylinders are placed inside the frames. The theoretical disadvantages attaching to the employment of a single driving axle with four cylinders do not appear to have made themselves felt in actual practice.

It is somewhat singular that with respect to the four purely British locomotive exhibits—those designed and built in England for the use of English railways—exigencies of construction should have compelled the adoption of outside cylinders in two out of the four cases, notwithstanding the strong British preference for the inside position. Mr. F. W. Webb placed his two 15-inch high-pressure cylinders outside the frame in the case of his compound engine "La France" because he could not get them inside, all the available space in that position being occupied by the two 20½-inch low-pressure cylinders. Mr. Wilson Worsdell was obliged to place his cylinders outside in his non-compound engine, No. 2006, because with six-coupled wheels 6 feet 1



NON-COMPOUND SIX-COUPLED EXPRESS ENGINE NO. 2006, NORTH EASTERN RAILWAY, ENGLAND, MR. W. WORSDELL, CHIEF MECHANICAL ENGINEER.

inch in diameter, 20-inch cylinders with a 26-inch piston-stroke could not well have been placed at such an incline as would have enabled the connecting rod to clear the leading coupled axle.

But in the other two British locomotives, Mr. S. W. Johnson's Midland express engine "Princess of Wales," and Mr. J. Holden's Great Eastern liquid-fuel-burning express engine "Claud Hamilton,"

the inside position is employed as a matter of course. As regards this particular method of construction, the practice of England diverges as markedly as ever from that of most other countries, notably the United States. Modern British engineers will not use outside cylinders unless absolutely forced to do so by some peculiarity in the plan of their engines. In my articles of last year on British and American Locomotive Practice I set forth the arguments commonly adduced.

I have already referred to the general development of haulage power in the engines shown as compared with those exhibited on former occasions. As the compound method has come into use mainly since the last Paris Exposition, and as the vast majority of the locomotives displayed in this instance are compounds, it is not easy to institute any precise statistical comparison between the relative tractive force possessed on the average by the locomotives of 1889 and those of 1900. I mean that, in view of the many discrepant and discordant estimates which exist as to the proportionate power exercised by a given cylinder diameter in a compound locomotive engine as against that of a non-compound, one cannot safely take the customary basis

$$\frac{\text{cylinder-diameter}^2 \times \text{piston-stroke}}{\text{diameter of driving-wheel}}$$

diameter of driving-wheel

—all in inches—because the results might be widely misleading in view of the difference among the designers of compound engines in respect of the best proportions between high-pressure and low-pressure cylinder dimensions. But the striking and valuable development of the past decade has been in the most important direction of all, namely in boiler-power and steam-pressure. For whereas in 1889, a boiler with 900 to 1,100 square feet of heating-surface was deemed ample for many of the most prominent express engines in England, such as those of the Great Northern and South Eastern lines, and a total heating surface of 1,200 to 1,300 square feet was rarely exceeded, there are very few main-line engines at Vincennes, other than British, which have less than 1,800 to 2,000 square feet, and even two of the four purely British express engines shown have 1,630 and 1,768 square feet, respectively, while M. du Bousquet's new engine for the Northern of France line, No. 2,642, has no less than 2,275 square feet. Again, in 1889 a steam-pressure of 160 pounds to the square inch was the maximum in ordinary use; 175 pounds was comparatively rare and was regarded as more or less of an experiment of dubious value. But in 1900 a large proportion of the engines at Vincennes have 200 pounds steam pressure or more. Most of the new French locomotives have 213 pounds at the least, and the newest of all, M. du Bousquet's

huge ten-wheeled "Atlantic" type, express No. 2,642, for the Northern line, and M. Salomons' eight-wheeled express engine, No. 2,411, for the Eastern Railway of France, have each a steam-pressure of no less than 228 pounds to the square inch. Of the four English engines, two—the London & Northwestern and North Eastern exhibits—have 200 pounds of steam pressure; the Great Eastern engine has 180 pounds, and the Midland 170 pounds. In this respect as in that of boiler-size, British progress travels on the lines of the old motto of one of its leading families, *Festina lente*"—"hasten slowly."

It is somewhat remarkable that the four British engines should differ so widely as they do, one from another. For it would have been possible to exhibit representative British engines from a number of railways which would all have been designed on identical main principles and which would have varied only, or chiefly, in dimensions and details. For instance, express engines—and new ones too—might have been shown by the Great Western, London & South Western, London, Brighton & South Coast, South Eastern, London, Chatham & Dover, Great Eastern, Great Northern, Midland, North Eastern, Great Central, Lancashire and Yorkshire, North British, Glasgow and South Western, Caledonian, Cambrian, North of Scotland, and Highland lines, all being among their most recent types and all agreeing in having inside cylinders, four-coupled driving-wheels 6 feet to 7 feet in diameter, and leading bogies. But the Great Eastern engine designed by Mr. Holden is the only British one at Vincennes which possesses all these characteristics. Mr. Webb's London & North Western engine is a four-cylinder compound with outside as well as inside cylinders; Mr. Worsdell's North Eastern engine has six-coupled driving wheels and outside cylinders; Mr. Johnson's Midland engine has single drivers 7 feet 9 inches in diameter. Here is as marked a variation as could well be found. The explanation, of course, is that each company and its chief mechanical engineer have exhibited what they deem to be their latest improvement in design and the type which they expect to become the standard one for the future. One could not help regretting that such new and interesting departures as Mr. W. Dean's "Atbara" (Great Western), Mr. D. Drummond's "720" (London & South Western), Mr. H. A. Ivatt's "Henry Oakley" (Great Northern), Mr. J. A. F. Aspinall's "1400" (Lancashire & Yorkshire) and Mr. J. F. M'Intosh's "900" (Caledonian) have not found a place.

One thing which must promptly strike the most casual observer is the exquisite finish of the work put into the four British engines that

are shown. And the more closely these locomotives are inspected the more obvious does this characteristic become. Every part, every detail, whether in sight or out of sight, is as delicately finished as if it were a portion of a chronometer. The same thing may be noticed in the case of a large number of the European engines. I am compelled to be candid in order to be just and accurate in my remarks, and candour forces me to say that this extreme finish is conspicuously absent in much of the work in the American engines. Indeed, the roughness of the jointing is in some instances quite surprising when it is remembered that the engines are exhibited as displaying the finest qualities of American workmanship in that particular branch of engineering manufacture. Nor is there the slightest attempt to conceal these roughnesses. Clearly this lack of delicate finish is not deemed by builders a defect of which they need be ashamed. How is this?

I incline to the opinion that, as it forms one feature of American locomotive-building policy to construct engines that will do all they are required to do and have even a margin to spare, but that shall not have a needless dollar expended upon them for purposes other than those of strict utility and shall not last so long as to become archaic while still too good to be "scrapped," so it forms no part of the American policy to conceal this method. Rather is it openly confessed by its frank obtrusion on the exterior surface of the machines. I have treated this question somewhat fully in my earlier articles on British and American locomotive practice and have entirely recognised that each country's system has much to be said in its favour, while open to various possibilities of hostile criticism. I need not retrace the ground over which I then travelled, especially as I shall have more to say on the subject when I come to treat of the working of American locomotives in Britain and in British possessions.

But I cannot quite follow my friend, the very able editor of *The Engineer*, in his conclusion that the American locomotives exhibited at Vincennes are likely to come to the scrap-heap after four or five years' work, and, indeed, are intended to do so. This I think is putting the case in its most extreme aspect, which is also one of some rhetorical exaggeration. I prefer to maintain my own view, already expressed—that whereas the British engine is designed and built to last thirty or forty years and so runs long after the type has become obsolete, the American engine is designed and built to last only ten to fifteen years, so as to be destructible without remorse so soon as a more modern type would advantageously fill its place. I express no final judgment on the merits of the alternative courses.

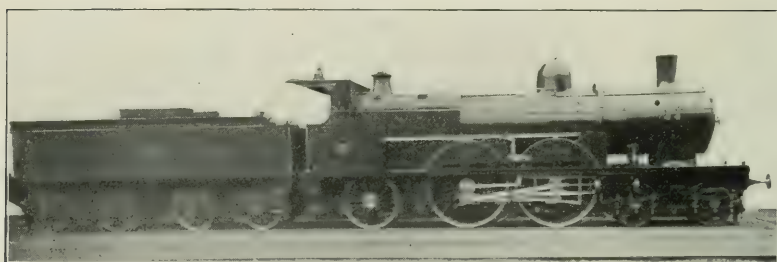
Next to the purely British exhibits—according to my definition of the term—comes an exhibit by a British firm of builders of a locomotive constructed by them for a foreign railway. I refer, of course, to the fine express engine "Koningin Wilhelmina," built by Messrs. Neilson, Reid & Company at their Hyde Park works, Glasgow, for the Central Netherlands Railway, having been designed by Mr. J. W. Verloop, chief mechanical engineer of that railway. I illustrated the engine last month. It is of a strongly British type, but is able to have a higher chimney and dome cover than would be admissible in England, superior altitude being allowed by the Dutch loading-gauge.

Following the British-built locomotive constructed for a foreign railway may reasonably come the American-built engine supplied to an English railway and ostensibly exhibited by the latter. This, too, may be taken as one of a hybrid class. It is a goods engine of the "Mogul" type with leading two-wheel pony truck, six-coupled wheels 5 feet in diameter, outside cylinders 18 by 24, 1,380 square feet of heating surface and 170 pounds' steam pressure. It is one of the "emergency" locomotives ordered from America owing to the impossibility of getting them built in Great Britain soon enough to meet



GREAT NORTHERN NO. 1200, BUILT BY BURNHAM, WILLIAMS & CO. AT THE BALDWIN WORKS, PHILADELPHIA, U. S. A.

urgent traffic requirements. It was built by Messrs. Burnham, Williams & Co., at the Baldwin works, Philadelphia, and is as a matter of fact exhibited by that enterprising company. It bears the Great Northern number 1200. It is unnecessary to devote much attention to this exhibit, because while the type is useful and efficient enough for practical purposes, it is not at all what would have been designed by an American engineer for the class of duty it has to perform. Nor is it either in respect of details the sort of engine that would have been ordered by an English engineer, excepting for the urgent necessity of accepting what could be got at the time. But it is a masterly commer-



NORTHERN RAILWAY OF FRANCE, NO. 2,642

cial stroke of the American builders to show their engine to the whole world as an accredited specimen of the latest thing adopted by so progressive a British railway as the Great Northern. There is an ingenuity in this advertisement that it is impossible to help admiring.

But Messrs. Burnham, Williams & Co. have done more than this in the same direction. They have on show at Vincennes a very fine Vauclain-compound express engine, constructed at the Baldwin works to the order of the State Railway of France, and ostensibly exhibited by that railway together with one of its standard express engines on the de Glehn system. The Vauclain compound supplied to the Etat railway is of the ordinary American type. It has two 13-inch high-pressure cylinders, and two 22-inch low-pressure cylinders, all placed outside. The piston-stroke is 26 inches. The four-coupled driving-wheels are 7 feet in diameter. The total heating surface is 1,903 square feet, and the steam pressure is 213 pounds. The engine weighs 54 tons in working order and has $31\frac{1}{2}$ tons' tractive adhesion.

Notwithstanding the lack of that minute and delicate "watch-finish" which is to be found in the British engines, and the absence of which in this case is so strongly commented upon by certain British critics, my own experience of American engines in various lands impels me to anticipate that this one and its brethren will be found to perform excellent service on the State Railway of France.

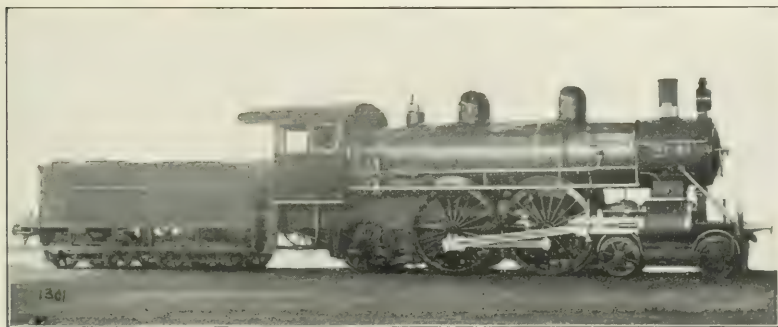
The type of engine which has more representatives than any other in the Exhibition of 1900 is the four-cylinder compound on the de Glehn system, illustrations of which are shown by every leading railway in France—the Nord, Orléans, Etat, Midi, P. L. M., Est, and Ouest—while several of these lines show more than one class of locomotives constructed on this system. In my previous article I referred to the magnificent express engine which represents the most recent development of the system, that designed by Monsieur du Bousquet, ingénieur-en-chef for the Chemin-de-Fer du Nord, and numbered 2,642.

Making a special trial of this engine I found it able to take a heavy express weighing 305 tons (English) behind the tender, from Paris to St. Quentin, a distance of 95 $\frac{3}{4}$ miles, in 90 minutes 52 seconds, start to stop, maintaining an average of 62.1 miles per hour up a 13-mile rising grade at 1 in 200—the minimum rate being 59.2—and 74.5 miles per hour on a long stretch of level and slight ascent. Down the falling gradients the speed was not permitted to exceed the limit prescribed by law, namely 120 kilometres or 74.5 miles per hour. This performance has no parallel in my personal experience.

The exhibits of the other French railways may be summed up in the remark that they are mainly variants of the Nord engines, formerly described by me, that is to say, they are four-cylinder compounds on the de Glehn system, with such differences and modifications of design as were deemed by the respective ingénieurs-en-chef suitable to the individual requirements of the particular lines.

One engine, however, belonging to the State Railway of France, which is shown at Vincennes, is in reality the exhibit of the Baldwin works, where it was designed and constructed. It is a very fine 7-foot coupled non-compound express engine of the Atlantic type, and is one of ten supplied by Messrs. Burnham, Williams & Co. to the Chemin de Fer de l'Etat. The French Midi company show a six-wheeled coupled engine of the "Mogul" class which has been converted from non-compound to the two-cylinder compound type.

The engines shown by the P. L. M. Railway of France, and also one of those exhibited by the State line, have the "wind-cutter" fronts that have so long been in use on the P. L. M line, not only the smoke-box but also the chimney, the dome-cover, and the cab being shaped so as to present a prow or acutely-angled wedge to the air passed through by the engine. As careful experiments have shown that the resisting



THE MONTAGU, NON-COMPOUND ATLANTIC-TYPE ENGINE. BUILT AT THE BALDWIN WORKS, PHILADELPHIA, FOR THE STATE RAILWAY OF FRANCE

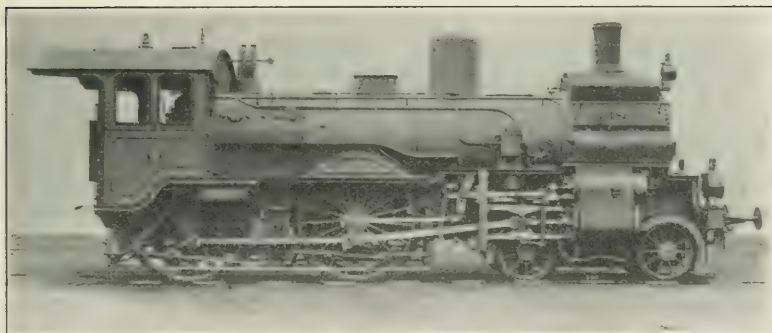
or retarding effect of an absolute head-wind is so small as to be virtually negligible, owing to the relatively small surface presented to it by an advancing locomotive, while the wind-cutters would present an *increased* surface of resistance to any wind at all on the side of the course, and would present the maximum of resisting surface to the worst wind of all—that blowing partly sideways and partly in front—I regard its effect as far more mischievous than beneficial.

Belgium exhibits a tank engine built for an English railway—the Barry line, of Wales—also three other tank engines of excellent construction, but of no special interest excepting one designed by Monsieur Bertrand, ingénieur-en-chef of the Belgian State Railway, and built by the Société de la Meuse. This bears a curiously close resemblance to the latest type of ten-wheeled tank engine designed by Mr. H. A. Ivatt, for the Great Northern Railway of England, having inside cylinders, four-coupled driving wheels, leading four-wheeled bogie, and a radial trailing axle. It is undoubtedly a very good and useful class of locomotive for heavy suburban traffic. Belgium also shows two very neat and compact six-coupled goods engines almost exactly similar, built for the Belgian State Railways. They follow so closely to the standard British type of “goods” or “freight” locomotive that no special notice is called for. Briefly they may be described as being each almost an exact replica of Mr. J. F. McIntosh’s standard type of goods engines used on the Caledonian line.

Switzerland shows some powerful locomotives designed for work on the steep gradients which prevail in that mountainous country. The four-cylinder, three-cylinder, and two-cylinder systems are all represented.

Some very large and massive Austrian engines are exhibited, chiefly of the two-cylinder compound—Gorlsdorf—type. A ten-wheeled express engine with six-coupled 6-foot wheels, 200 pounds steam pressure and a weight of 69 tons; a huge double-ended mogul-class goods weighing 70 tons, and a consolidation-class goods of 69 tons weight, are among the most noticeable.

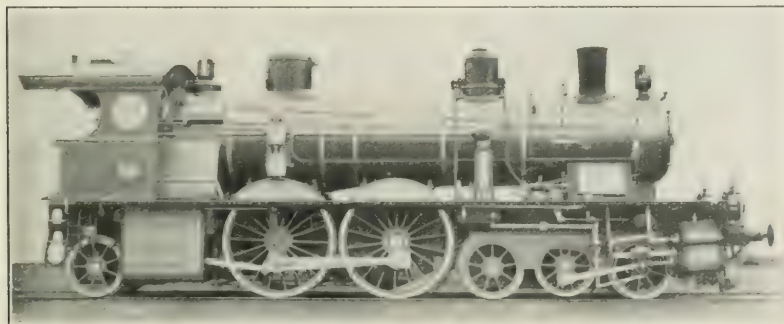
Among the Hungarian locomotives, a fine 7-foot coupled, two-cylinder compound express weighing 64 tons may be commended, but the most remarkable of the Hungarian exhibits is a double-four-coupled articulated Mallet compound goods engine which has each separate set of four-coupled wheels driven by its own pair of outside cylinders, one high-pressure and one low-pressure, one set being virtually a steam bogie, somewhat after the Fairlie method. A similar mode of construction occurs in one of the large Russian engines to



GERMAN EXPRESS ENGINE WITH STEAM SUPER-HEATER. A. BORSIG, BERLIN.

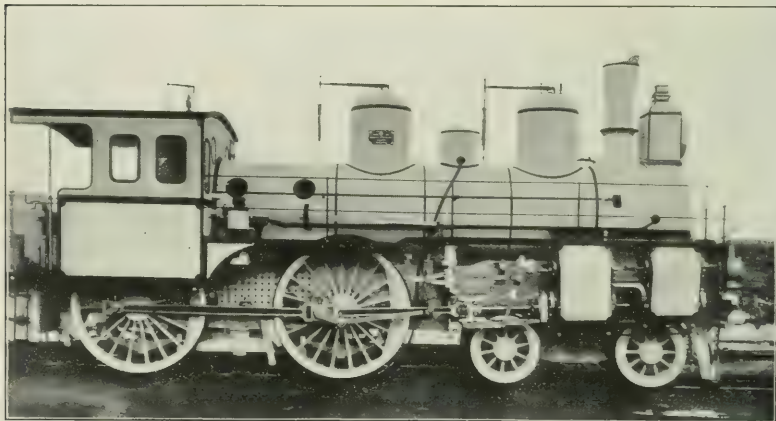
which I shall have occasion to refer directly. In the case of the Hungarian locomotive, it seems to me that this complicated plan of construction does not promise results at all commensurate with its costliness or compensatory as to its manifest drawbacks.

In the German section several interesting exhibits are to be found. A complex engine on the Klose system for working a rack-railway; a still more complex ten-wheeled tank engine, partly four-coupled and partly six-coupled—which would require a whole magazine-full of description to itself to make its design clear—the motion being transmitted from one set of coupled wheels to the other by an elaborate system (Hagan's) of rods, etc.; the peculiar Krauss engine with independent "donkey" assistant working between the two wheels of the leading bogie—referred to in my first article; another Krauss engine, a huge ten-wheeled four-coupled express weighing 68 tons, having a leading Bissel truck and a trailing four-wheeled bogie; and a fine four-coupled express by Borsig, with a steam super-heater appended to its smoke-box—all are notable and merit fuller notice than space permits me to bestow.



GERMAN EXPRESS ENGINE WITH OPTIONAL AUXILIARY MOTOR. KRAUSS COMPANY, MUNICH.

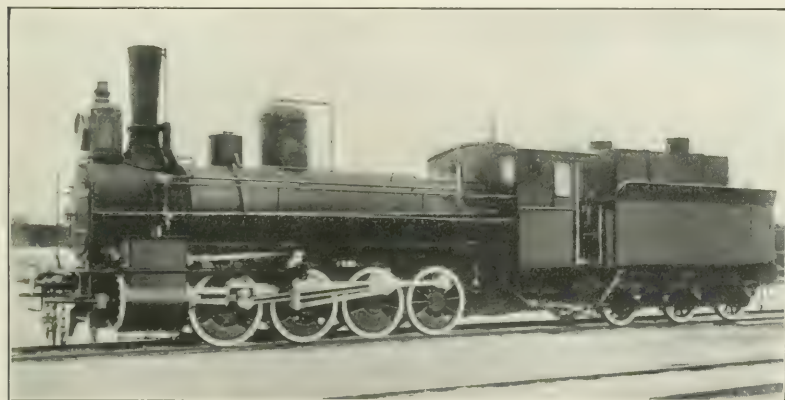
One of the two Italian exhibits, that shown by the Adriatic line, was noticed in my previous article. It is a four-cylinder compound, but in addition to the peculiarities already described it has this other one, that both its high-pressure cylinders are placed on one side and both its low-pressure on the other, contrary to the usual—and, in my opinion, preferable—practice of placing one high-pressure and one low-pressure on each side, while the cylindrical valve-chests give it the quaint appearance of possessing six cylinders. The second Italian engine is an extremely fine ten-wheeled six-coupled express locomotive with leading bogie; a two-cylinder compound with both cylinders outside, and coupled wheels 6 feet in diameter, belonging to the Mediterranean system.



LOCOMOTIVE FOR ST. PETERSBURG AND WARSAW RAILWAY, RUSSIAN GOVERNMENT LINES.

As to the Russian engines, it may be generally said that their vast size is their most striking feature. One is a "consolidation" goods, two-cylinder compound, weighing 65 tons and having a low-pressure cylinder no less than $29\frac{1}{4}$ inches in diameter, so that, as the eight coupled wheels are only 4 feet 1 inch in diameter, the cylinder-casing seems but slightly above the rail level. Another is a four-coupled express on the four-cylinder tandem-compound system. A third is a ten-wheeled two-cylinder-compound express with six-coupled drivers 6 feet in diameter, leading bogie, and outside cylinders. But the most remarkable Russian engine is the gigantic twelve-wheeled double-six-coupled duplex compound, on a modification of the Mallet system, and bearing the number H. 810. This is by far the biggest and heaviest engine in the whole Exhibition, weighing as it does 86 tons, and having a vast 46-ton tender appended; the total weight of engine and ten-

der being therefore no less than 132 tons, while the top of the chimney stands 16 feet 9 inches above the rail-level. This mighty locomotive is constructed on the articulated plan, the 4-foot driving wheels being coupled in two groups of six each, one being practically a steam bogie, while each group is driven by one high-pressure and one low-pressure cylinder, the respective diameters being 18¾ inches and 28 inches. In the case of this particular engine, more may be said on behalf of the complex system of articulation employed than in the case of the smaller but similar locomotive previously referred to. The Russian twelve-wheeler is intended for the haulage of immense loads and the ascent of steep grades. It is essential to the development of its full usefulness that it should be able to utilise its entire adhesive weight for traction, and that this weight should be distributed as widely as possible upon the rails without such distribution involving an undue length of rigid wheel-base. The plan adopted appears to satisfy these requirements in theory, at all events. How it works in actual regular practice I have not as yet had any opportunity of ascertaining.



ENGINE FOR THE RUSSIAN GOVERNMENT RAILWAY.

Summarising the Vincennes show of locomotives as a whole, I may say that there are 64 steam locomotives exhibited, of which 37 are compound and 27 non-compound. Of the former 18 have four cylinders, 16 have two, and one has three cylinders. In the total number of locomotives only one has single driving-wheels; 30 have four wheels coupled; 17 six wheels coupled; 4 eight wheels coupled, and 4 have articulated systems with the coupled wheels in two groups. All these are of the normal or the Russian gauge. There are also 8 engines for a gauge of one metre or narrower. In addition to the 64 steam locomotives, there are 3 electric

motors of various designs; several tramway engines and a large number of magnificent passenger-cars and goods-waggons. Within my present limits I must confine myself to the remark that of the different types of valve-gear in modern use the Walschaert is applied to no fewer than 44 of the 64 locomotives exhibited, the Stephenson to 10, and the Gooch to two.

My review would be incomplete did I neglect to notice one most extraordinary steam locomotive which is to be seen at the Paris Exhibition, but not among the others in the Vincennes Annex, specially appropriated to that object. It is the enormous express engine shown by Messrs. Schneider et Cie., of Creusot, France, as the central figure in their great display near the Eiffel tower. It runs on no fewer than *fourteen* wheels, four being coupled and 8 feet 3 inches in diameter. It has a leading four-wheeled bogie and a trailing six-wheeled bogie. The two cylinders, 20 inches by $27\frac{1}{2}$ inches, are outside and drive the front pair of coupled wheels. The driver is provided with a wind-cutter cab in front of the smoke-box and can communicate by means of speaking tubes with the fireman, who occupies the footplate in the ordinary position. The engine alone weighs 81 tons: the total heating-surface is 3,250 square feet. The tender is enormous and runs on ten wheels, disposed in two bogies, one six-wheeled, one four-wheeled. Thus the engine and tender together run on twenty-four wheels. This tremendous machine, which is stated to have been built for swift "International Trains," was designed by Monsieur Thuille, who unfortunately lost his life during some preliminary experiments with his huge creation. The Schneider locomotive is undoubtedly a magnificent piece of mechanism, but I have been unable so far to discern its *raison d'être* or any satisfactory promise of such results as alone would justify what must be its excessive costliness. Also, it certainly appears to me deficient in constructive strength, but it would be premature at present to hazard any definite or final judgment upon a design so novel and as yet virtually untried in regular practice. It is, however, undoubtedly one of the most striking features in the French locomotive exhibition of the closing year of the nineteenth century.

NOTE.—In my previous article (September issue), Page 887, line 7 from foot of page, the printers have by mistake repeated the line which occurs four lines above. The sentence should have read as follows:—"Neither Mr. F. W. Webb nor Mr. Wilson Worsdell, the chief mechanical engineers of the only other British railways exhibiting at Vincennes, has ever built any single-wheelers at all for his line, although each has rebuilt and improved one class of single-wheeler left by his predecessor. Thus, as Mr. Pollitt, who built the new single-wheeler for the Great Central, has just retired from his position, and his successor's antecedents rather discourage the idea that he will perpetuate the type, it would appear that Mr. Johnson and Mr. Ivatt will be the only British engineers to continue building single-driver locomotives."

EDITORIAL COMMENT

If current reports are correct, November will witness an experiment in shipment of steel from Pittsburg to Liverpool which may have great meaning for the trade on both sides of the Atlantic. Four British steamers which have been trading between Canadian river and lake ports, it is said, are to load for home with 1,000 tons each of steel from the Carnegie works, taking on the freight at Conneaut, the terminus of the "Carnegie Company's railway," the Pittsburg, Bessemer, and Lake Erie. The ships thus laden to 14-foot draft will proceed by lake, river, and Welland and St. Lawrence canals to Montreal where they will complete loading with wood pulp and clear for home.

The motive of the attempt is the effort to avoid the alleged excessive freight from Pittsburg to the Atlantic seaboard. Talk of the independent railway line to tidewater, which Mr. Carnegie was said to be contemplating, has given way to rumours of a Carnegie line of freight steamers running between Conneaut, on Lake Erie, and European ports. The conditions do not seem highly favourable. The canals will not pass any but ships of comparatively small size and relatively low transport economy; navigation is slow and troublesome to Montreal, at least; the open season is short, probably not more than seven months; lastly, though it is a small factor, the Carnegie railway, we believe, is laid out particularly with a view to favouring traffic movement from Lake Erie to Pittsburg, and will not be quite so economically operated in moving goods the other way. However, the result of the experimental shipment will be observed with the utmost interest.

* * *

Progress of the anthracite-coal strike in Pennsylvania makes it more clearly

apparent than ever that the establishment of unionism rather than the redress of any grievances is the chief end sought. The operators have offered an increase of wages to a figure which, as one commentator put it, "would make coal-miners' heads swim" in any other part of the world. The arbitrary charges for powder have been waived. Employers generally have expressed entire willingness to discuss or arbitrate any differences with their own workmen. But the strike goes on under the purpose of making the mine-owners "recognise" the United Mine Workers of America, and employers who are not chargeable with any of the abuses complained of are deserted by their men without a moment's consideration. The Markle collieries, where an arbitration agreement had been in force for years, were shut down with the rest; the men simply broke their pledge. It was a "military necessity," the union leaders say, and probably the most telling example of labour's irresponsibility which has been exhibited of late. When the test comes the responsibility of labour melts into thin air. When the unions are in position to make enforceable contracts to furnish labourers on their agreed terms, they will command greater respect as negotiants.

* * *

A number of months ago we took occasion in these columns to call attention to the lack of a good technical dictionary, one which should really give the working equivalents of the terms used in engineering and technology in English, French, and German. The suggestion was then made that this work could best be accomplished by the co-operation of the various technical societies on both sides of the Atlantic, the definitions in each case be-

ing made or revised by experts in the languages of the several countries.

This matter has now been taken up by the *Verein deutscher Ingenieure*, and that society has undertaken the labouring oar in the work. Communications have been made by the German society to a number of other bodies, soliciting their aid in the good work, and there is every reason to believe that this important undertaking will be carried out with German thoroughness and success.

It is not only in the provision of the correct meanings of technical terms in the various languages that co-operation is required, since many expressions differ in meaning in England and the United States, so that some careful editing will be needed in that connection.

It is to be hoped that the responses from the different organisations which have been invited to join in the work will be favourable. A good beginning has been made by the American Society of Mechanical Engineers, which has decided to assist in the work to the extent asked by the German society—that is, to furnish the editors the names of specialists from whom accurate definitions may be obtained; and as the actual expense will be entirely assumed by the *Verein deutscher Ingenieure*, there is every reason for all the solicited societies to meet this generosity by the expenditure of only a little time and trouble.

It is most gratifying to find so prompt a response to the suggestion which, we believe, first originated in these columns, and we trust the good work will be carried to a prompt and satisfactory conclusion.

* * *

The laws of supply and demand may be depended upon to work out the solution of natural problems in one way or an-

other, and when, as sometimes appears, the direct result is not practicable, some indirect development is later seen to be the result of unsuspected causes.

The rise in the price of coal really means a demand for more power, and the demand for power is gradually being solved by the extended utilisation of natural sources. A glance over the various reviews of the technical press of Europe and America elsewhere in this issue cannot but reveal the tremendous strides which are being made in the exploitation of water-power in various parts of the world. France especially has awakened to the vast resources available within her own territories, and Italy and Switzerland are not far behind. Costly black coal is to be offset with the power from the cheap "white coal," as the snows and glaciers of the Alps have well been named, and the work of the sun, stored in these masses of elevated water, unlike the earlier work of the same great source stored ages ago in coal, is constantly renewing itself, and cannot be wasted or exhausted.

England, indeed, has not the same sources of energy available as are in the possession of the continental competitors, but she has long been wasting vast quantities of energy from the tops of her blast furnaces which now, in the demand for power, will no longer be permitted to run to waste.

The whole question has become the immediate problem for the engineer, and he can be depended upon to solve it successfully.

When George III. visited the works of Boulton and Watt to see the building of the engines which were to add so much to England's prosperity, he was met by Matthew Boulton, who said :

"Your Majesty, we furnish here what all monarchs desire to possess—Power!"



REVIEW OF THE BRITISH PRESS

The Burden of Coal.

THERE has been much written and said of late about the changing conditions in the production, distribution, and use of coal, and for an excellent review of the whole situation reference may be made to an article by Mr. Benjamin Taylor, in a recent issue of the *Nineteenth Century*. Mr. Taylor well states at the start that the subject of coal is of national importance to every Englishman, because "not only is it a material indispensable to each individual's comfort, but also because our industrial prosperity and national greatness are inseparably bound up with it."

That coal has risen greatly in price, everyone knows, but just why it has risen at the present time, and whether the rise is permanent or temporary, is not entirely clear to everyone. Some maintain that the rise in price is due to the war in South Africa. This is true to a limited extent. It suspended the production of the South African coal mines, and it increased the demand for steam coal for the transports and troopships. Mr. Taylor shows that the coal exports for 1899 were 55,335,369 tons, as against 47,827,000 for 1898, and the first seven months of 1900 show a proportional increase.

The figures for 1900 so far also show, what is worth noticing, that, while there has been a general increase in coal exports, the quantity shipped for use of steamers in the foreign trade has decreased by 227,000 tons, which may be attributed to the larger supplies of cheaper American coal at the foreign stations.

The true cause of the scarcity of coal, however, is rightly stated by Mr. Taylor to be the increasing requirements for industrial purposes. Of these requirements by far the greatest are those due to the great demand for iron and steel. "A large part of our export of coal is, indeed, in the form of iron. Every ton of pig-iron smelted and exported represents the con-

sumption of from two to two and a half tons of coal, and every ton of rolled iron and steel represents from six to eight tons of coal."

This being the case, it would seem as if there was no way of reducing the demand for coal without diminishing the demand for iron and steel, something surely not to be desired. If coal is to be saved only by restricting manufacturing industry and manacling shipping, small relief to the nation would be attained. To be sure there are other increasing uses for coal, the growing demand for power, the increase in electric traction, electric lighting, higher steamship and railway speeds. All these mean rapidly increasing demands for power, and its source, coal, which mean increasing prosperity, growing civilization, national progress; things certainly not to be checked if possible.

The question, therefore, is not how to restrict the demand, but rather how to meet it. Comparison at once is instituted with American coal, for last year the United States passed the United Kingdom in its output of coal, and is now the largest producer in the world. Not only is the United States the largest producer, but is also able to produce at a lower cost than any country in the world, excepting only India. "The best American steam coal is said to be, to all intents and purposes, as good as the best Welsh, and at the present moment it is less than half the price per ton at the port of shipment!"

In looking for the causes of this disparity in prices we have not far to seek. Briefly they are found in more accessible coal and a vastly greater output per person employed. It is a fact that in the American mines they can turn out 70 per cent. more coal per man in the year than in the British collieries. This is doubtless partly due to the increased efficiency of the men at the more moderate depths, and possibly also to the more general use of machinery.

Relief in the future for Great Britain, at least, must be looked for in various directions. First of all, high prices will enforce the necessity of economy in production, and especially in consumption. The use of the most economical boilers and engines may reduce the coal used for power nearly one-half, especially if power distributed electrically from central stations is substituted for very wasteful small engines and boilers. Metallurgical operations may be conducted with producer gas made from cheap, inferior coals, and with liquid fuels. The tremendous waste of power now permitted with the discharge of waste gases from blast furnaces will be stopped, the gas being converted directly into power in gas-engines, and the power electrically distributed. With these will probably come some imports of American coal, since the cost of transport will surely be reduced below the present rate.

"If a return current of raw coal from American in persistent volume is not probable, though not a commercial impossibility, a permanent current of consumed coal in the shape of iron and steel may surely be looked for. This will gradually effect an industrial revolution, as we shall have to find employment for our energies in manufactures not so dependent on cheap fuel. This may be looking a long way ahead, yet the conditions of the problem of the immediate future relate rather to the development of the coal resources of the United States than to the exhaustion of those of Great Britain."

Electric Stimulus.

VERY early in the history of the study of electricity the similarity between the electric phenomena and those of vital functions was observed, and the recent paper of Professor Chunder Bose before the British Association brings the result of his usual painstaking investigations toward new results bearing in the same direction.

Apparently Professor Bose has carried his study of Hertzian waves so far as to have demonstrated that these waves generate an electric stimulus by stressing the molecules of the material whatever its condition, whether in large or finely divided particles. The only difference is the depth to which the waves are able to act. In

some cases an increase of resistance is produced, in other instances the reverse; some materials recover quickly, others slowly. The whole action is so analagous to that of living tissue as to demand the closest study of electricians and physiologists, and some of the conclusions may be very surprising. While it is hardly yet a subject for the engineer, yet it is difficult to say where the realm of engineering begins or where it ends, and all students of the science of force and controlled motion will at least find the paper of Professor Bose suggestive of thought and progress.

The Cost of Power Generation.

AMONG the various papers presented before the recent meeting of the British Association, that of Mr. J. B. C. Kershaw upon the comparative cost of various methods of power generation is of especial interest to engineers.

Except in special instances, the steam engine has long enjoyed supremacy as a prime mover, but its position is now assailed on two sides, on one by the revival of the use of water power, on the other by the various forms of internal combustion motors generically grouped under the title "gas-engine."

The remarkable increase in the use of water-power in Europe, and the investigations on the Continent having for their end the further utilization of this source, are reviewed at length elsewhere in this issue, and there is no need to emphasise the fact or discuss its commercial importance. On the other side, the development of the gas engine and the practical demonstrations which have been made of the successful construction and operation of large sizes, from 100 to 1,000 horse power, have raised this type of motor from its former comparatively unimportant position to the rank of a worthy and formidable competitor of the steam engine. In some cases the choice of a motive power is decided by extraneous considerations; the proximity to a water source, or to a coal field, determining the selection of water or steam power. "In the great number of cases, however, especially when the decision of the engineer covers the choice of a site for the factory, the problem is capable of no such easy solution, and the

most economical source of power can only be determined after an exhaustive study of comparative costs data. There has been an immense mass of information bearing on this subject published in recent years, but no attempts have been made to co-ordinate these facts and data, and comparison between them in their existing form is unproductive of any useful results."

Mr. Kershaw has certainly gleaned carefully from current technical literature, and endeavored so to arrange the data that they may be compared and studied. In view of the general practice of continuous running in hydraulic power plants he has converted the results into costs per year of 8,760 hours, the figures being classified according to locality, so that labour conditions and other local influences may be taken into consideration.

An important cause for variation in the cost, especially of water-power, is the wide variation in the capital outlay. In some cases very little expensive preliminary work is required, and the main cost is that of power-house equipment. In others there is a large expense for dams, canals, transport of materials, or concessions. The capital outlay per horse power ranges from £3 9s. 3d., at Vallorbes, and £84, at Lyons.

There is an equally wide variation in the charges to consumers, although in this case the variation is partly dependent upon the cost of distribution. In Norway, the price is £1 per electrical horse power per year of 8,760 hours; at Niagara, the average charge is £4 6s. 7d.; although it is much higher delivered to small consumers in Buffalo.

In regard to steam power, the tables compiled by Mr. Kershaw shows that in America, for engines of more than 1,000 horse power, the costs are £6 2s. 6d. to £6 6s. 3d., while in Switzerland the lowest cost of steam power is given at £9 per year. In order to compete successfully with water power, steam power must be generated in bulk, when, with coal at 7s. per ton, Raworth estimates that a 50,000 horse power plant could produce power at a yearly cost of £3 14s. per horse power.

Turning now to gas power, much depends upon the source and character of the gas. The superior economy of gas engines

over steam engines is especially marked with motors of moderate size, and it is not necessary to have the very largest sizes to secure the advantages of the high thermal efficiency. According to the estimate of Meyer, using blast furnace gas, an electrical horse power can be produced at a cost of £4 rs. 7d. per year, while an estimate for Mond producer gas puts the cost at £5. Taking the lowest estimated costs in each case, these checking well with the lowest actual costs in the cases of water and steam power, the following table gives the final conclusions:

POWER,	COST.	COUNTRY.
	£ s. d.	
Water	1—5—5	Canada
Steam	4—18—8	England
Gas (furnace)	4—1—7	Germany
Gas (producer)	5—0—0	England

These figures support the opinion, now generally held, that water, when developed without excessive capital expenditure, is the cheapest source of mechanical or electrical energy. "When, however, the hydraulic engineering expenditure has been heavy, or when the power after generation has required to be transmitted over long distances, the margin between the relative costs of water and steam power is greatly narrowed, and in some cases disappears altogether.

"Electrical energy, generated by falling water, is costing more at Rheinfelden, at Zürich, and at Buffalo, than it would cost in South Lancashire, if generated by steam power in large units, and the margin between the actual charge for water power at Niagara, and the estimated cost of steam power in large generating stations in South Lancashire, is only 12s. 1d. per electrical horse-power year."

In regard to gas engines, the question of practicability may be regarded as settled, but it is still unsafe to prophesy upon their place in industrial development. "If they do not cost excessive sums for maintenance and repairs, large gas engines—in conjunction with coke ovens and blast furnaces—may entirely alter the present position of affairs, and new industries which at present are being established in the neighborhood of water-power stations may find themselves in severe competition with similar manufactures carried on in the coal

and iron districts of the older manufacturing countries.

"It has been calculated that 2,000,000 horse power is annually wasted in the gases issuing from the blast furnaces of the United Kingdom. If these waste gases could be industrially utilised in the manner suggested, we should to a large extent be compensated for our lack of natural water-power. But blast furnaces demand coke, and coal beds are exhaustible, so that even if this source of mechanical and electrical energy be tapped, it can only postpone, but not avert, the final triumph of the waterfall and of the turbine."

The Association Screw Gauge.

THE second report of the Screw-Gauge Committee of the British Association, published in the *Journal of the Society of Arts*, and in other publications, contains so much that is of interest to engineers that it should be read by all, and an abstract can by no means do the subject justice.

The main point of discussion was the matter of providing standard gauges for the B. A. threads because of the difficulty in making an accurate fit of the rounded ends. The method proposed to prevent this difficulty is that of avoiding it, perhaps the best solution of the problem. For very small screws, such as are used in watch-maker's work, and in which the rounding is so slight as to be almost inappreciable, no change is to be made, but for the larger sizes, known as instrument-maker's screws, the top of the thread is to be flat and with a clearance.

The conclusions of the report are as follows: For screws from No. 0 to No. 11, inclusive:

For Screws:—That the designating numbers, pitches, outside diameters, and the common angle of $47\frac{1}{2}$ remain unchanged; but that the top and bottom of the thread shall be cylindrical, showing flats in section, and that the depth of the thread shall be increased by one-tenth of the pitch, the diameter of the solid core being, in consequence, diminished by one-fifth of the pitch.

For Nuts:—That the designating numbers, the pitches, the diameter of the clear holes, and the common angle of $47\frac{1}{2}$ remain unchanged; but that the top and bottom of the thread shall be cylindrical, showing flats

in section, and that the depth of the thread shall be increased by one-tenth of the pitch.

A table is given showing the dimensions of the modified screws, and much interesting information concerning the investigations and experiments which led to the conclusions.

The Iron and Steel Institute.

THE Presidential address of Professor Sir W. Roberts-Austen at the Paris meeting of the Iron and Steel Institute is filled with matter of the greatest interest, but from its length we can only make a few abstracts, and refer the interested reader to the full text, which appears in several of the technical papers of the month, and will doubtless appear in the *Journal* of the Institute.

The principal point emphasised in the work of the metallurgist is that the main characteristic of the metallurgical work of the century has shown the interdependence of minute quantities of matter on the masses of metal in which they are hidden. The century's work, has, moreover, to a great extent revealed the way in which the small quantities of added matter act, and it has been shown that they exert profound influences even in solid metals; the fact that certain varieties of steel are "solid solutions" is now accepted, and the recognition of molecular movements in solids has become familiar.

Reviewing the progress which has been made during the closing century in the metallurgy of iron and steel, Sir Roberts-Austen touches briefly on the work of Davy, Dumas, Sainte Claire-Deville, Berthollet, Regnault, le Chatelier, Bessemer, Siemens, Osmond, and many others. The successive advances which appeared in the working and using of iron and steel at the various international exhibitions were shown to be making points in the progress of the art. Taking the three periods between the exhibitions of 1855, 1867, 1878, and 1889, the progress in each may be indicated by the words, "novelty," "quantity," and "quality." Taking the period from the exposition of 1889 to the present, and the advance is best characterized by the single word "intensity."

Two distinct lines of work have been followed in the last decade in the develop-

ment of iron and steel. The first of these has been in the preparation of new alloys of iron; and the second in the study of the properties of iron and its alloys.

The alloys to which attention has been mainly called are those of iron with chromium, alloys with nickel, and alloys with manganese.

In all of these valuable properties have developed and practical applications made. In the coming century it may be that alloys with vanadium, uranium, molybdenum, and even glucinum may prove as important as those with the better-known metals.

The improved methods of investigation may be divided into those employing thermal measurement, for the study of the physical properties of iron and its alloys; and those which study the structure of iron and the grouping of the constituents in its alloys by the use of the microscope. Both have been extensively worked in England and France, and also in the United States and Germany, and the results have been altogether encouraging.

In closing the address Sir Roberts-Austen said:

"The part played in the industrial evolution of the world by iron and steel metallurgists will be evident to all. The fact that they have contributed with commensurate success to the advancement of pure science is less generally known, and I may well, therefore, devote a few words in conclusion to recording some instances which readily present themselves. The carburisation of iron offers the first case in which the diffusion of solids in solids was observed. The study conducted by metallurgists of the associations of carbon and iron affords the most complicated case yet known, and indeed the only one which has been worked out, of metallic solutions. It presents, however, a unique case of the importance of allotropy in connection with the metals. In 1,000 parts of steel, 997 parts, more or less, may be iron and the rest carbon, but the result of the union is a metal that is more widely used and has more varied attributes than any other. It would seem that Nature has enshrined in steel a series of her most complex secrets, which we must discover as a condition of our successful use of it.

"Metallurgists have carefully investi-

gated, and conduct daily, operations of vast industrial importance, in which the presence of a third body enables either elementary bodies or compounds to react on each other. Habitually conducting operations at high temperatures, which often invert ordinary chemical reactions, has led to the acquisition of a mass of information as to the reactions that do occur, and the compounds that are formed under such conditions. Pyrometric records, have, moreover, enabled the equilibrium of the less fusible metals in their liquid as well as in their solid state to be studied—a branch of work which chemists generally have not been in a position to undertake. The necessity for submitting the physical and mechanical properties of iron and its alloys to rigorous tests, as a routine operation in works, has afforded a rich store of information as to the molecular constitution, not only of metals, but of matter generally. Metallurgists have to deal with cases in which a mass of metal is acted upon by added matter in proportions that are too minute to intervene directly by the formation of chemical compounds with the whole of the mass, while in some cases no compounds are formed. The influence of the atom must, therefore, be more or less directly exerted. Hence it is that we, who still conduct processes, the traditions of which came down to us from mythological times, have done our share in 'giving the old Greek atomism a modern and a higher consecration.'"

The Iron and Steel Question.

THERE is no doubt that the iron and steel trade in England is a subject for serious discussion, and hence a recent editorial in *Engineering* is especially timely.

Naturally, the question is one of demand and supply, and the ship-builder and others on the side of the demand look for their supply where they can get it the cheapest, all other things being equal. The steel producer finds that fuel and labour are the controlling elements of cost of his product, and it is in these two items that he finds his strongest competition elsewhere, particularly in the United States.

"There coal is comparatively cheap, and labour enters into the cost of producing iron to much less extent than is the case

in this country, so that the wage is not a dominant factor. And thus it comes that American steel is now being imported in increasing quantities into the Clyde and Belfast yards."

In addition to the competition of American steel in the home market, comes the cessation of orders from other countries, notably Germany, and hence the reason for an inquiry into the state of the trade at the present time.

It is decidedly time that the false doctrine of restricting output in order to maintain prices should be refuted. It is a truism that such artificially maintained selling prices only encourage foreign producers and strengthen foreign competition. The true effort should be toward reducing the cost of production.

In order to show the true condition of the trade as regards American competition, the productions of the United States and Great Britain are plotted in the form of comparative diagrams. These diagrams, for which the reader is referred to the original paper, show that at the present time the output of pig iron in America is 40 per cent. greater than that of Great Britain, while the product of steel is more than twice as much!

"Even if there should be no further augmentation of this yearly output, its maintenance threatens our trade, for there is every reason to assume that the present abnormal demand in America cannot continue, and the fiscal conditions and control over the supply will enable American makers to sell in foreign markets at lower prices, while maintaining rates at home. Indeed, already there are large consignments of American pig iron being sent to the heart of the Scotch iron district."

As the situation now stands, the United States have the advantage of lower prime costs, largely due to the easily-won minerals, to their great bulk, and to the facilities for handling and transporting coal and ore. To these must be added the effective utilisation of mechanical appliances, and the reduction of middleman's profit, and from them must be deducted the charge of over-sea freight rates. These latter may overbalance the cost advantage in the immediate British market, but in colonial markets America must have the gain, geo-

graphical conditions often assisting. The truth of these conclusions is affirmed by the facts in regard to America's advance in foreign markets. In seven years the total exports of manufactures of all kinds from the United States have more than doubled; the exports of iron and steel have increased from £14,000,000, in 1898, to £24,000,000, in 1900, an increase of £10,000,000 in two years! The development in Germany is also a matter for consideration. It is an interesting fact that, although the whole of the steel for the Kaiser Wilhelm der Grosse came from Britain, the same shipbuilding company—the Vulcan Works, of Stettin—get all their steel this year from German works.

When the question is asked, What is to be done? the first thing is to arrive at a full realisation of the character and extent of the foreign competition, and to study the causes by which it has been brought about. "Foreign competition in iron and steel is a reality, and requires the careful consideration of workmen as well as—perhaps more than—employers, for the future demands a reduction in the prime cost of production of all constituent minerals and in steel manufactures as well, and this can only be achieved by the liberal provision of modern plant, and by the use of it to the fullest advantage possible."

American and British Blast-Furnace Practice.

At a time when American products of iron and steel are crowding British products in home and colonial markets, the paper of Mr. T. B. Rogerson, before the West of Scotland Iron and Steel Institution, is both appropriate and interesting.

In making the comparison, Mr. Rogerson is in a position to speak whereof he knows, since he has spent about eight months recently in the United States, visiting most of the large blast-furnace plants in the iron-making States, and being given excellent opportunity to observe American practice.

The high reputation of Scotch pig iron renders it especially appropriate that the Scotch furnaces should be selected by Mr. Rogerson for comparison with the American ones; and, in fact, with the exception of the fact that English furnaces use coke and the Scotch use raw coal, the Scotch

practice, is fairly entitled to be considered representative British practice.

The Scotch furnaces are about 65 feet high and 15 to 17 feet diameter of bosh, and are worked at a blast pressure of from 5 to 6 pounds, the blast being heated to 1,100° F., to 1,300° F. in Cowper or Whitwell stoves, the hot-blast main being usually common to all the furnaces in a plant. The coal is handled in charging barrows, at the rate of one ton per barrow, being taken up a steam hoist to the top of furnace and dumped in by means of the ordinary bell and hopper arrangement. This is followed by the barrows containing the mixture of ore and limestone, all being hand-filled, the men doing about 60 tons per day each. The slag is taken away from these furnaces either by running it into holes in the slag fall and hauling the pieces away when set, or else the liquid slag is hauled away in tubs or ladles of 4 to 12 tons' capacity. The iron is run out of a tapping-hole into a sand bed and cast into pigs, and when cold is carried away by hand, broken, and deposited in trucks for conveyance to the steel works. The tuyeres are cooled by being made of coiled pipe through which water flows, while the slag tuyere is formed of two annular brass cones, with water space between. The blast tuyere is stopped with specially prepared clay, and the furnace must be thrown off blast to do this, but the brass tuyere is stopped with an iron plug, which can be done with the furnace on blast. The tapping hole is stopped by hand with specially prepared clay, and it generally takes about ten minutes to do this, the furnace being off blast during this time.

"English blast furnace practice is very similar to Scottish, except that coke is almost entirely the fuel, the labour, or form of filling, etc., being the same as in Scotland. In a few places, however, they use blast up to 8 and 10 pounds pressure, and have also apparatus for lifting the pig iron, either in the whole grid, and breaking it with a specially constructed machine, either hydraulic or steam, and delivering it sampled into railway wagons, or gathering it up into slings of about 2 tons, and delivering into wagons.

"With these few exceptions there are no labour-saving devices other than those which were in force thirty years ago in

Great Britain." The maximum output of a British furnace is about 1,200 tons per week, with 10 pounds blast pressure.

In the United States the furnaces are much larger, the output per furnace greater and the cost of production lower than in Great Britain. The furnaces are from 80 to 100 feet high, and from 17 to 20 feet bosh, with 8 to 16 tuyeres. Hot blast stoves are used, but each furnace has its own outfit, so that the blast can be varied in each case as desired. The blowing engines are more powerful than in England, furnishing blast at a pressure of 10 to 18 pounds per square inch, and the more recent engines press up to 25 pounds, a single engine making blast sufficient to make 400 tons of pig iron per day.

The material is handled by machinery as much as possible. The charge is conveyed to the top of the furnace in specially designed buckets, holding about 4 tons, the bottom of the bucket fitting the top of the furnace bell in such a manner that the charge can be delivered into the furnace without the escape of any gas. The time required to take up the charge, deposit the contents, and bring the bucket back requires about two minutes, and the whole filling of the furnace, about 700 tons per day, is done by one hoist engineman and three men on the locomotive which hauls the charge to the furnace.

The slag is run off through a copper tuyere into ladles holding from 10 to 15 tons and taken away for deposit in liquid form in a convenient place. The iron comes in the ordinary way from the tapping hole, and is run into large ladles, and taken direct to the steel works or to the casting machines. The hole is stopped, after the cast is done, by the use of a mechanical appliance, so that neither in the case of the slag nor the iron is it necessary to shut off the blast.

The great makes of the American furnaces are due to the greater pressure of the blast, bringing the charge down very rapidly and causing quick smelting even with the large proportion of small rich ores used. When the output of the furnace is raised to 2,000 to 5,000 tons per week the questions of regular filling and the disposal of iron and slag present themselves. The result has been the replacement of the laborious

work of men by machinery, and by the introduction of the casting machine to deal with the quantity of molten metal that could not possibly be handled in sand beds at the furnace. The result has been a cheapening in the cost that, in connection with abundant ore and fuel, has enabled the American iron-making industry to reach its present commanding position and causes its competition to be felt everywhere.

It will not do for Great Britain to continue the use of obsolete methods and appliances. As Mr. Rogerson forcibly says: "Let every pig-iron making son of a blast furnace pull himself together and not be always hankering after things that his grandfather did. These things were good enough in their day, but these days have gone."

The Transport of American Coal to Europe.

IN view of what has been written of late about the competition of American coal to markets now largely supplied from British sources, an editorial in a recent issue of *The Engineer* regarding the matter of transport is of interest.

"Coal as an article of export is by no means in the same category as manufactured iron and steel. By virtue of proximity to the fuel and ore deposits, advanced methods of manufacture, and low railroad charges to the seaboard, the United States are in a position to compete with European manufacturers of iron goods in spite of the many miles of ocean which separate it from most markets. But that distance must prove an effective bar to a foreign coal trade of any magnitude, save in exceptional times such as the present, at any rate, while the United Kingdom has supplies into which the Continent may dip so long as it chooses to pay the price. The freight of three or four dollars per ton makes all the difference between profitable and unprofitable business.

The question having been reduced to one of transport, it is interesting to note the manner in which the changed front of the problem is being attacked.

"It must be allowed that, having realised what is the great obstacle in the way of a foreign coal trade, the Americans are displaying characteristic energy in the endeavour to remove it. Is it possible, they

are asking themselves, so to reduce the cost of carriage across the Atlantic as to afford reasonable hope of a steady profit on shipments? Freights on ordinary 'tramps' will be reduced later when the pressure for tonnage is relaxed, but by that time the cost of English coal on the Continent will also be lower; and, anyway, if the charge for carriage across the Atlantic by the existing type of vessel were reduced to the lowest point consistent with profit to the owners, the cost would still be appreciably above the margin desired. In this contingency there has arisen a demand for a special class of collier—a vessel of large carrying capacity, low cost of construction, with sufficient engine power to steam seven or eight knots an hour, and give steerage way in all weathers, equipped with the best machinery for handling cargo, and with minimum requirements as to size of crew and consequent operating expenses—a vessel, in short, built specially for the export coal trade, and which will do for it what the tank steamer has done for petroleum, and the steam barge for the ore and coal trade of the Lakes.' It is believed that if the great coal-carrying railroads of Pennsylvania, Maryland and Virginia were equipped with a fleet of such vessels, and could give a through rate on coal from the mines to foreign ports the problem would be solved. It would at least be in a better way to be solved, but even then there would be doubts, because England possesses an enormous initial advantage. However, the American people believe that a big trade is possible, and aggressive preparations are being made by railroads, coal operators, shipowners, and shipbuilders, to say nothing of the speculator, who hopes to make a little out of the situation. The railroads interested are uniting for a reduction in the cost of carriage to seaboard, and for the provision of better terminal facilities; the Chesapeake and Ohio Coal Company, which controls the Newport News ship-building plant, proposes to construct a fleet of colliers, and the Baltimore and Ohio, among others, is talking about doing the same thing. The tank steamer saved the export petroleum trade to Europe. It will be interesting to see if the colliers—which, by the way, have yet to be built—create a foreign trade in coal."



REVIEW OF THE CONTINENTAL PRESS

The Iron Industry in the Urals.

IN a recent issue of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* is given an extensive abstract of the very complete report made to the Russian Minister of Finance by Professor Mendeleeff upon the present state of metallurgy in the Ural mountains, with especial reference to the iron industry. In undertaking this important task, Professor Mendeleeff had the assistance of a number of trained specialists, but the various reports were edited by him, and the general report and conclusions are the personal work of the great Russian chemist and mineralogist.

The great mountainous barrier between Europe and Asia, known as the Urals, began to be considered as a metallurgical centre during the seventeenth century, and by the efforts of Demidoff, Strogonoff and others the former nomad population was largely replaced by Russian immigrants. At first the efforts of the miners were directed only toward the extraction of gold and copper, but the energy of Peter the Great directed the exploitation of the rich deposits of iron ore, the proximity of immense forests supplying ample fuel, and for a time the iron of the Ural became widely known for its purity. Subsequently, however, the industry was overshadowed by the gold mining, and it was not until after the enfranchisement of the serfs, and the development of the mining region of the Donetz in 1880, that the iron industry of the Urals became once more of importance.

At the same time, the development of the Ural district has not kept pace with that of the Donetz, and an examination of the causes of this difference forms an important portion of Professor Mendeleeff's report. Thus the mining operations in the Donetz district starting in 1883 had attained an output in 1888 of 5,000,000 poods (80,000 tons), at which time the Ural district produced 22,000,000 poods (338,000

tons). Ten years later, in 1898, the product of the Donetz was 61,000,000 poods (970,000 tons), while the Urals had reached only 41,000,000 poods (660,000 tons). The total product of iron in Russia during the same ten years had increased from 41,000 poods to 136,000,000 poods (2,190,000 tons).

Among the causes for the slower development of the Ural district Professor Mendeleeff names several which are doubtless susceptible of removal or relief. Apart from the difficulties of local transport, the question of fuel is important. In the Ural there are no coal mines suitable for iron making, and charcoal is not suitable for large output and modern intensified methods, while in the Donetz district coal is abundant. This, however, is by no means the principal cause for the slower development of the Ural district. The main reason is the energetic influence of private initiative, with its scientific and practical application of ample capital.

At the present time the demand for iron in Russia is increasing, and the native product does not meet the demand, there being extensive imports. Thus in 1898 the total consumption of iron in Russia was 193,000,000 poods (3,100,000 tons), while the home product was 136,000,000 poods (2,190,000 tons), the balance being imported.

The sole reason for importing any iron into Russia is the question of price, and with the rich deposits of ore in the Ural district there is every reason why iron should be made as cheaply in Russia as anywhere. The great difficulty lies in the primitive method of conducting the management of the industry. A portion of the territory is controlled and also operated by the government, and the balance is under control and operation of great estates following similar methods. According to M. Mendeleeff, the government furnaces constitute the principal obstacles to development. They produce very little iron, and yet they prevent free competition. The

future of the Ural depends upon the suppression of these works, which bring no revenue to the state, but are rather an expense. This is especially true of the central portion, in which the principal government mines are situated. In the northern and southern portions the metallurgical industries are in the hand of private parties, and there is a much more favorable state of affairs.

The conclusion of M. Mendeleeff's report is well worth quoting:

"If the government follows the necessary measure we have indicated we shall see the Urals in a position to furnish iron and steel for Europe and Asia at a price much lower than is now admitted in Europe."

In order to accomplish this result but two or three years are necessary; within five years, at least, the Ural should be able to furnish its products at a low price. This conviction is based upon the inexhaustible riches of the mines and forests of the district. The Kamorowsk mines alone contain more than 100 milliards of poods (1,612,000,000 tons) hematite ore, 50 per cent. pure. The ore is exposed to the surface, and the ground is covered with dense forest, the district being on the banks of the Larabia river and only 30 versts (20 miles) from the Avziano-Petrovsk furnaces of the Ural-Volga Company. This is but one of a number of deposits, and when the rich mineral ores of this district of the Russian empire are developed in accordance with modern business and scientific principles Russia will not only cease to become an importer of iron and steel, but will be in a position to control the markets of the rest of Europe and Asia.

The Hydraulic Power of the Rhone.

ONE of the far-reaching consequences of the application of electricity to the transmission and conversion of motive power is seen in the continual efforts which are made on every hand to utilise sources of water-power hitherto partially or wholly neglected. Formerly only such water powers were utilised as lay in immediate proximity to commercial and manufacturing centres, and even these were not employed to their full possibilities. To-day we hear continually of new schemes for the control

of streams and rivers, and see these schemes successfully exploited, both technically and financially.

In a recent number of the *Memoires et Compte Rendu* of the Société des Ingénieurs Civils de France there is a communication by M. F. Bonnefond upon the hydraulic power available in the upper Rhone within the French boundary, which contains some valuable information.

As is well known, the Swiss Rhone is utilised very effectively, especially in the vicinity of Geneva, the lake there acting as a reservoir in a very effective manner. In the portion extending from Pymont to Fort de l'Ecluse, near the Swiss frontier, in a distance of only about 12 miles, there is a difference in level of 210 feet, with a discharge, during periods of low water, of 5,300 cubic feet per second. It follows that in this stretch of 12 miles there is available a minimum effective capacity of more than 100,000 horse power. If, instead of taking the minimum discharge of the river, we consider the mean flow available during 9 or 10 months in the year, it is perfectly safe to count upon the development of 200,000 horse power.

Of this power, 10,000 horse power are already utilised by an Anglo-Swiss company, while three other projects, under the auspices of French companies, are only awaiting the completion of the legislative formalities to begin constructive operations. Two of these schemes are comparatively simple. The first, at the "Passe de Malpertuis," utilises a fall of 35 to 40 feet at a point where the stream passes between rocky bluffs only about 160 feet apart, and by boring a tunnel of about 650 square feet cross section, and 6,000 feet long to an available point below on the river a total head of nearly 60 feet may be obtained, developing about 25,000 h.p. even in winter, when the flow is diminished because of the frozen condition of the glaciers.

The second project is similar, and is planned for the curve in the river known as the "Boucle du Rhône." Here the river is wider, and it will be necessary to construct a dam about 328 feet long and about 20 feet high. A tunnel starting immediately above the dam will carry about 5,000 cubic feet of water per second, for a distance of 4,600 feet, discharging into the stream at a

point near the village of Arlod, and securing a head of about 90 feet, with a development of 30,000 h.p.

The third undertaking demands rather more notice, as it involves more elaborate construction works. The location is at the "Pont de Gresin," a small bridge across the Rhone about 7 miles from the Swiss frontier and a short distance above Bellegarde. Here the river flows through a narrow gorge about 80 feet deep, with a mean depth at the bottom of 25 feet of water, the width of the upper part of the gorge being 75 to 80 feet. An eroded chasm in the side of the gorge provides a convenient situation for a power-house, there being an area of more than 200 feet wide and 1,200 feet long available, and by damming the stream a short distance above, a very effective power-plant can be erected.

The proposed construction of the dam is interesting, and is practically similar to that which has already been successfully applied at Bellegarde by the Anglo-Swiss Company. Instead of constructing a solid masonry foundation, a platform of iron beams is thrown across the gorge at the low-water level, and upon this is erected a solid masonry structure, forming the upper portion of the dam. This work can be rapidly and thoroughly done during the winter months, when the water is low. A number of iron beams are also placed in an inclined position, running down from the masonry structure into the river bed, forming a grating covering the space below the water level, and against this grating a mass of rubble stone work is heaped, forming an obstruction to the stream which quickly becomes filled with the drift and gravel brought down by the water. The upper portion of the dam is provided with an opening which can be closed to any necessary extent by movable weir-needles, and thus the water level above the dam controlled to any desired extent.

It is expected that this plant will be capable of developing 30,000 effective horse power, and it is planned to convert this into electric energy in the power-house by means of 15 polyphase generators of 2,000 h.p. each.

These three schemes are, therefore, definitely planned to utilize about 100,000 horse power, not only in electro-chemical and

electro-metallurgical industries in the vicinity, but also to transmit power to existing and developed industries within a radius of 120 to 150 kilometres. According to careful estimates, it is stated that the average price of a horse power per year, operating 24 hours per day, will not exceed 50 francs, or about one-tenth the price of a steam horse power under similar conditions.

The Progress of the Simplon Tunnel.

THE appearance of the seventh quarterly report of the Jura-Simplon Railway enables the latest information of the progress of the work upon the Simplon tunnel to be obtained, and from an abstract in a recent issue of the *Schweizerische Bauzeitung* the following data of the present condition of this important work are taken:

The total length of the completed tunnel is to be 19,729 metres, or about twelve and a quarter miles, and of this distance there were completed in June, 5,644 metres; the penetration being 3,252 metres on the northern, or Brieg side of the mountain, and 2,392 metres on the Italian side at Iselle; so that about 28 per cent. of the boring is completed. These figures refer to actual penetration, but it must not be understood that they represent completed tunnel. In the first place, as is well known, there are two parallel tunnels being constructed, of which at first only one is to be made the full size for a single track railway, the other being used for ventilation, and ultimately enlarged to full size when the demands of traffic shall require a double way.

The smaller tunnel has been carried along nearly as far as the main boring, there being frequent cross-connections to enable the ventilation to be effected, this being all the more necessary because of the remarkable rise in temperature with the increasing penetration. Thus on the Swiss side the temperature at a distance of 2,800 metres from the entrance was 23.9° C., while at 3,200 metres it had increased to 26.8° C., a rise of 3 degrees in 400 metres. On the Italian side the temperature is still higher, having attained 33.5° C. at a penetration of 2,200 metres. These results are higher than were expected, previous experience having led the engineers to antici-

pate a maximum temperature of not more than 25° C.

When the tunnel is completed and opened for traffic it will be practicable to establish such a complete ventilation as to prevent discomfort from heat, but during the execution of the work it requires powerful ventilation through the auxiliary tunnel to relieve the workmen from the heat.

Valuable data are given in the report as to the quantity of rock removed per day, and the weight of dynamite for a given removal of material, while the general results of the work are tabulated in convenient form for reference.

Automobile Torpedoes.

SUBMARINE warfare is undoubtedly destined to play an important part in naval conflicts of the future, and improvements in the mechanical devices connected with this branch of fighting machines are naturally to be expected. While much interest attaches to the submarine boat, the older apparatus, the automobile torpedo, will undoubtedly continue to hold its place as a subject for study and experiment.

In a recent communication to *La Revue Technique*, M. H. Noalhat discusses the construction of the Whitehead and the Howell torpedoes, and then proceeds to describe the improved directing device of Obyr, intended as an improvement on the Whitehead torpedo.

In order to understand the action of the Obyr device, it is necessary to describe briefly the characteristic features of the Whitehead torpedo, this weapon now being used by nearly all European governments. The cigar shape of the torpedo is well-known, and in the Whitehead type it is propelled by two screw propellers on the same shaft, revolving in opposite directions, and driven by an engine operated by compressed air. The explosive charge is in the front, and the steering is provided for by two devices. The rudder for direction is fixed before the torpedo is launched, the adjustment being regulated according to the currents at the moment. The rudder controlling the immersion is movable, and is actuated by an auxiliary motor governed by the pressure due to the depth of immersion.

Notwithstanding the success which has

been attained by the Whitehead torpedo, and its adoption by many governments, it has defects. Apart from its complication, and the delicate mechanism which it contains, it is subject to frequent initial deviations from the intended course, and in fact it is hardly possible to estimate the influence of currents with sufficient accuracy to permit a close adjustment of a fixed rudder.

The Howell torpedo, adopted by the United States government, differs from the Whitehead in the use of the stored energy in a rapidly revolving fly-wheel as a motive power, instead of a compressed-air motor. Experiments have shown that this torpedo has a much greater accuracy of direction than the Whitehead, and there is little doubt that this greater directional stability is due to the gyroscopic action of the heavy, rapidly revolving fly wheel.

In the Obyr device the action of the gyroscope is not applied directly to steady the direction of the torpedo, but is used to control the steering apparatus, and thus correct any material deviation from the original line of launching.

It is well-known that a rapidly revolving wheel with a heavy rim possesses a strong tendency to remain in the plane in which it originally began to revolve. In the Obyr device such a revolving wheel is placed in the rear portion of the body of the Whitehead torpedo, the wheel being suspended in double gimbal mountings, similar to that of a ship's compass, and started in rotation at the instant of the launching of the torpedo. Connected with this free gyroscope is an auxiliary motor, so arranged that it is thrown into action by any deviation of the torpedo from the original position, the gyroscope remaining in the original position and forming an abutment against which the connecting levers act.

The auxiliary motor, in turn, acts upon the rudder, and as soon as the torpedo has been brought into the original direction the action upon the rudder ceases until a new deviation occurs.

In practice this device has been found to improve the steering of the Whitehead torpedo very materially, the deviation from the original line of direction not being greater than 2.5 metres in a distance of 200 metres, or about 1 per cent.

The Influence of Railway Development.

THE influence of environment upon the development of the inhabitants of any locality is well known, and it is reasonable to assume that any important modification in surroundings and habits of life will be reflected in the development of a country. It is therefore interesting to examine the effect of such an important influence as that which the changes in transportation due to the introduction of railways have made. Under the suggestive title of "Countries, People, and Railways," a paper was recently presented by Herr von Mühlenfels before the German Railway Association, and published in *Glaser's Annalen*, showing the influence of railways in general upon various nations of the world.

This phase of railway economy was foreshadowed as long ago as the middle of the century by von Weber, who called attention to the results which might be expected from the more general intermingling of national characteristics with the increasing facilities for communication. During the last quarter of the closing century this fact has been especially manifested, and in the course of his paper Herr Von Mühlenfels enumerates the development of railways in the various countries of Europe, and shows how it has been accompanied with the general advance of nations.

One of the most impressive influences of railway development in Europe is found in the effect upon military methods, the transportation of troops and supplies by rail having metamorphosed the whole system of tactics. The semi-military organisation of the railway personnel, too, has had its influence upon other branches of commercial life, extending as it does into every department of industry.

Apart from the entrance of such a systematic and methodical organisation into the general life of a community, the railway has accomplished what may appear to be almost the contrary effect in the awakening influence which it has had upon quiet towns and villages, previously dependent upon ordinary highway and river traffic for their communication with the rest of the world. There is to-day in most countries no town of moderate size which is not kept in close and active touch with the doings of the rest of the world, while

the man who has travelled a few hundred miles is no longer looked upon by the villager as a great explorer and adventurer, as in the early years of the century.

In addition to the effect upon existing towns, the railway is responsible for the development of what may practically be considered as new cities, these being mainly manufacturing centres situated in localities always favorable for industry, but dependent upon economical and rapid means of transport. Such cities as Manchester, Sheffield, and Birmingham could never have attained their present commanding positions without the railway, and it is a matter of history in England that the changes in parliamentary representation which have brought many communities to the front politically have been due to the changes in the distribution of population brought about by industrial changes for which railways are largely responsible.

Herr von Mühlenfels enumerates at length the progress of railways in various countries, naturally giving the predominance to Germany, and his whole paper is a valuable and interesting contribution to a feature in political economy of modern growth and one hardly given sufficient consideration by writers and students. It is, in fact, only one phase of the controlling influence which the work of the engineer is gaining over the whole conduct of individual and collective life, and counterparts could be found in many other lines of engineering work.

The Alps as a Source of Power.

SINCE 1897 there has been at work a commission, appointed by the French Minister of Public Works, investigating the hydraulic power capable of being developed by the entire Alpine region, including the water-sheds of France, Italy and Switzerland, and the report of this commission forms the most important contribution to the recent quarterly issue of the *Annales des Ponts et Chaussées*.

It is naturally difficult to make precise estimates of the actual amount of hydraulic power available, but the researches of the commission were facilitated by the statistics of various sections in which river and stream gaugings have been made from time to time, supplemented by their own observations. It is especially desirable that

some reliable investigations should be made at the present time, since many vague, unreliable, and exaggerated statements have been made upon what may really be called guesses rather than scientific estimates. Selecting from among these the most reliable, we find that it has been estimated that France possesses about 10,000,000 horse power, undeveloped; Italy, 2,640,000 horse power, and Switzerland, 582,833 horse power. As a matter of fact, there are now actually developed in each of these countries the following amounts, neglecting all installations smaller than 200 horse power; France, 113,364 horse power; Italy, 250,000 horse power, and Switzerland, 200,000 horse power.

In endeavoring to obtain more definite figures, the French commission have considered the Swiss method of investigation the most reliable, and with some modifications have recommended that this system be used, taking each basin in succession and examining the capacity of those surfaces which may properly be considered pluvial. This will involve the installation of numerous stations for the observation of rainfall, in a more complete manner than is possible with the existing meteorological observatories. Such special stations will necessarily be employed also in observing conditions of stream flow and the issue of flood warnings.

In considering the utilisation of the water as a source of power, due consideration must be given to the demands for purposes of agriculture and navigation. So far as the question of navigation is concerned, especially of the smaller streams, it is a matter of minor importance, while for the larger ones, such as the Rhone, the hydraulic-power works may also be utilised to improve the navigation. By the use of movable dams and a system of lateral canals, the river, with its estimated total capacity of 800,000 horse power, might be converted from an impetuous torrent into a veritable hydraulic staircase, and be rendered alike serviceable to navigation, agriculture and industry. The benefit of an ample supply of cheap power must also be of great benefit to agriculture, and assist in irrigation in manner not otherwise possible, so there is no reason why these important interests should be antagonistic.

After a careful examination of the whole subject, the commission adopted the following rule for the estimate of the hydraulic power obtainable for any given district: The flow of the streams under consideration is observed during the period of low water, being the three winter months; for the remaining nine months of the year the mean flow is taken. The low water flow, multiplied by three, is added to the mean flow multiplied by nine, and the sum is divided by twelve for the yearly mean. This flow is multiplied by the total available fall to obtain the power. The gross horse power is taken at 100 kilogrammetres per second (the so-called "Poncelet"), this leaving a margin of 25 per cent. for loss in conversion into effective horse power on the shaft. In all cases the volume of water required for local irrigation purposes must be deducted. As an example, this rule is shown applied to the department of Hautes Alpes, and the result is a mean value of about 500,000 horse power. Using the data at present available for the stream flow, the total power available in the ten departments comprising the French Alps is computed to be 3,000,000 horse power for the season of low water, and 5,000,000 horse power for the yearly mean flow.

An important section of the report is devoted to the question of the cost of the power thus available, although, as may be supposed, it is difficult to arrive at exact figures. Two conditions are given as tending to cheap cost of installation of hydraulic power plants. The head of water should be great, and the plant should be a large one. The advantages of a high head are analogous to those obtained by the use of electric currents of high voltage, the expense of pipes and of turbines are both reduced, and in most cases machines of higher efficiency are at the same time obtained. The advantage of generating a large amount of power in one station is true in this case, as in the general economy of large establishments for any purpose. The fixed charges are proportionally a much less amount of the whole than in smaller plants.

The cost of the power is made up of two elements; the interest on the cost, together with the depreciation of the plant, and the operating expense. This is only true when

the power is sold at the shaft of the turbine, and in the great majority of cases a certain charge must be added for transmission and distribution.

So far as the cost of installation is concerned, experience in France has shown that in no case does this fall below 100 francs per horse power, and in some cases it is much higher; a maximum may be taken at 300 francs. In Switzerland, where the costs are necessarily higher, it is held that a plant costing more than 1,000 francs per horse power cannot be operated at a profit, while in Italy, where coal is more expensive, the profitable limit is still higher. M. Blondel assumes that 8 per cent. is a proper charge for interest and depreciation, and that 2 per cent. is enough for operative charges, so that the net cost of the power on the shaft may be taken at 10 per cent. on the cost of installation.

Taking the cost of installation, for a large plant, at 100 francs per horse power, and again at 1,000 francs, the cost of power in each case for transmissions to various distances, is tabulated in the following manner:

	Installation cost 100 francs per h. p.	Installation cost 1,000 francs per h. p.
Gross h. p. on shaft	10 francs	100 francs
Electric h. p. at works=1.20 hyd- raulic h. p.	27 francs	135 francs
Electric h. p. at 20 to 50 km.—1.- 50 hyd. h. p.	60 francs	195 francs
Electric h. p. at 20 to 50 km. in- cl. distribution=2 hydraulic h. p.	110 francs	290 francs

The report contains a vast amount of useful information concerning the possible applications of the vast amount of energy available in France, and also discusses at length questions of legislation which necessarily enter into problems involving such valuable property rights.

The Reliability of Steam Indicators.

THE prominence which has been given of late to the results of studies upon the experimental engine in the mechanical laboratory of the University of Liège under the direction of Professor Dwelshauvers-Dery lends especial interest to the paper by his former assistant, M. Georges Duch-

esne, in a recent issue of the *Revue de Mécanique*, upon the methods of testing the indicators used in the work.

The indicator is supposed and intended to record the pressure in the cylinder at every point in the stroke, and in order that this may be accurately done it is necessary that the abscissas of the digram be directly proportional to the path of the piston and that the ordinates be directly proportional to the pressures existing within the cylinder. If these conditions are not rigorously met in the instrument and its application, and it is practically impossible that they shall be so met, it is necessary to compute and apply proper corrections if very close deductions are to be drawn from the diagram. The manner in which the calibrations for these corrections were made in the laboratory at Liège, as described by M. Duchesne, form an interesting example of the care with which the investigations have there been conducted.

Considering first the reducing motion and its connection to the paper drums, in the experimental engine at Liège the reduction is made by the use of an eccentric on the engine shaft, this eccentric being set exactly in line with the main crank, and of such radius as to give the desired reduction. The motion of this eccentric is conveyed by rigid rods as near as practicable to the indicators, so that the connecting cords are not more than 10 centimetres long, and the effect of stretch is reduced to a minimum. In order to test the accuracy of the reducing method, a scale of the exact length of the stroke, divided into 1,000 parts, was attached to the guides and a vernier fixed to the cross-head, thus enabling the position of the piston at any point to be determined with great precision. By comparison of measurements thus made with points marked on the diagram, the accuracy of the reducing motion was shown to be of a very high degree.

The method of calibrating the springs was that of direct weighting. The indicator was exposed to the action of steam long enough to enable the parts to become hot, and was then clamped in an inverted position to a bracket, so that a rod could be inserted into the cylinder and press upon the piston. Equal weights were then successively placed upon the rod, and the com-

pression of the spring in each case marked upon the paper drum. The return of the spring upon the removal of the weights was also marked, and thus the extent and uniformity of the spring movement was tested. It will be noted that this test also included the correct proportionality of the multiplication by the parallel-motion levers, and hence gave a correct calibration of the transfer of the piston movement to the pencil point. The result of these tests showed that many springs were unsatisfactory, but that after many trials it was possible to select those which gave results within the permissible limits of error.

These points being determined, the remaining disturbances were those due to the weight of the moving parts, to the force necessary to provide the necessary acceleration of the mechanism of the instrument, and the resistance due to friction.

The influence of the weights of the various parts was determined by taking the actual weights and reducing them to their equivalent value referred to the axis of the cylinder, and in the case under consideration it was shown that apart from being of negligible magnitude, the action was constant in value and sign, and hence without influence upon the form of the diagram.

The action of acceleration is less simple, but may be plotted graphically, so that the magnitude and location of the maximum effect may be determined. Taking into account the varying velocity of the paper-drum, including the effect of the angularity of the connecting rod, the constructed diagram showed that the maximum effect of the acceleration in the particular case under consideration corresponded to only 0.0007 millimeter on the ordinate of the indicator diagram, this maximum occurring practically at the moment of admission, there being practically no influence during the period of compression.

The measurements for friction were made with the aid of a delicate balance, the spring being removed from the indicator and the piston, rod, and system of levers being suspended from the bottom of one scale-pan and the resistance to motion weighed by adding weights in the other pan until motion was produced. The maximum value for frictional resistance was

found to be 50 grammes, corresponding to 1.5 of a millimeter on the ordinate of the indicator diagram.

The details of the methods by which these corrections were determined form an interesting study of the methods employed in the laboratory at Liège, and the account given by M. Duchesne is a valuable contribution to the practical side of scientific investigation in steam engineering.

Dirigible Balloons.

THE recent experiments of Count Zeppelin in attempting to direct and propel an air-ship of the balloon type against the wind, is taken as the occasion by Herr von Loessl, well-known for his theoretical studies in wind resistance, to discuss other attempts to solve the same problem. In a recent issue of the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines*, he reviews the work of Giffard, De Lôme, Hânlein, Tissandier, and especially of Renard and Krebs.

The subject is naturally one which depends mainly upon the exposed area of the balloon and the available surface which can be given to the guiding and propelling apparatus, and also includes the important question of motive power of light weight and large capacity. Herr von Loessl also calls attention to the important part which is borne by the method of attachment of the propelling and guiding machinery to the gas reservoir, lightness and stiffness both being essential, as well as strength.

The great difficulty is that of ability to stem even moderate winds, and nearly all the successful trials which have been made have taken place in still air or against very light winds. There has, however, been a continual improvement in this respect. The machines of Giffard and of De Lôme required 2 to 3 seconds to traverse a metre, while that of Renard and Krebs traveled 7 kilometres in 23 minutes, and the Zeppelin machine went 5 kilometres in 15 minutes, both machines thus making about 5 metres per second. These velocities are so much less than even moderate winds, however, that there appears to be small probability of practicable navigation of the air by this method. Herr von Loessl's paper is an interesting résumé of the present state of the art.



The Education of Railroad Men.

IN a recent paper before the Association of Railway Superintendents, Mr. Walter G. Berg discussed in a very interesting manner the question of the education of railroad men for subordinate positions of responsibility, more particularly with reference to employees of the bridge and building departments. There is a distinct difference between professions and trades, or callings, and the education appropriate to each possesses a corresponding difference. If such a difference is not made there will be a mistaken tendency to lower the professional education, in a mistaken attempt to make it come within the scope of the subordinate field of work.

"In place of dragging down the college course to meet the requirements of the middle class of railroad men, the aim should be to extend the college system still higher, broadening its scope by adding studies on such general subjects as history, law, finance, transportation, and operation of railroads, so that it will turn out thinkers and originators, men to guide and teach the masses, minds trained to cope with unknown factors and difficult problems, investigators and promoters in every branch of the railroad business."

This view is generally held by students of the science of education, but the question of the proper character of education for the subordinate positions has not been so carefully considered.

"That there are numbers of subordinate and yet important occupations on a railroad for which no preparatory education exists, is apparent to anyone familiar with railroading and educational institutions."

There are isolated attempts for elementary instruction, and various forms of night-schools, but no recognized national system of preparatory railroad schools for the lower grades of the railroad service.

It is manifestly impracticable to have the various railway employees leave their

regular duties during the day to receive class-room instruction. The education, whatever it may be, should have been at least partially received before that stage in the career of the employee has been reached at all. The great point is the desirability in the training of the employee in the real fundamentals of his work, so that what he may learn thereafter may rest upon a proper foundation, regardless of the manner in which the later information is acquired. At the present time the laborer or helper on a bridge or building gang takes the place, not because he has any especial aptitude or ambition for the work, but simply because he wants the job. If he can get a slight advance in pay in some other department he drifts off, and so shifts about without any permanent basis or idea. Other workmen who have learned their trades through apprenticeship are good workmen, but their skill is limited to the especial class of work in which they have been trained.

How different this would be if a boy, on leaving public school, would select his future calling and study for a year or two with that in view. A knowledge, such as he could readily acquire in some special department, would make him gladly welcome in such work, and after acquiring the necessary mechanical skill and practical knowledge, he would be better qualified to be promoted and gradually given a responsible position with benefit to himself and the company.

Mr. Berg gives a detailed schedule of the subjects which he thinks could be taught to advantage in an elementary way in a railroad trade school, with especial reference to the department of bridges and buildings, and then proceeds to enunciate his ideas upon the general question of the education of future railroad officers and employees.

He maintains that:

"First: A clear division should be main-

tained between the higher and middle classes of railroad men, and the preliminary educational systems kept distinct and separated from each other.

"Second: The higher class, offering the material from which, as a rule, the future managers, professional men, and heads of departments will be drawn, should be provided for by special railway departments at existing colleges, and by adding general railway subjects to the present curriculum of the technical departments of colleges.

"Third: The middle class of railroad employees, comprising young men entering the railroad service in subordinate positions of all kinds, many of whom will some day fill the large number of responsible minor railroad positions of trust, should receive, after leaving the ordinary school course, a special short preliminary schooling adapted to the particular departmental work they expect to take up on entering a railroad shop or office. This special education will be obtained most advantageously in special railroad trade schools to be established wherever desirable and possible throughout the country, the curriculum to consist of a one-year 'Regular Course' divided into suitable departments. Further, an 'Advanced Course' covering a second year, for such scholars who desire and have the means and qualifications necessary to continue their studies to a more advanced point."

The general programme for such a school as is suggested by Mr. Berg is given in his paper, to which the reader is referred. While it seems rather full for the elementary training which it is intended to cover, and while it seems rather extensive for the limited time assumed to be available, yet it contains many good points, and is well worthy of examination. There can be little disagreement with the general contention that a sound fundamental training in general principles will make better employees out of subordinates than is possible in the absence of any such training, and that the opportunities for promotion would at the same time be vastly in favor of the employees so trained.

The Rating of Incandescent Lamps.

In the recent issue of the *Journal of the Franklin Institute*, Mr. Arthur J. Rowland discusses very fully some mistakes which

are often made in the rating of the illuminating power of incandescent electric lamps. Most people go by the manufacturer's label, but as many manufacturing establishments go to the trouble of weighing what they buy, instead of depending upon the dealer's weights, so many people are beginning to find it advisable to have electric lamps tested before the photometer. Not only should the user of incandescent lamps know that the lamps he buys really possess the candle-power which is marked on them, but he needs to know how that candle-power is maintained, as well as many other things about the relation between the power consumed and the light emitted.

The modern method of lighting calls for a proper distribution of illumination rather than of lamps, and in every case attention should be given to the places where the light should really be concentrated. In the case of a library it is the table which needs to be brightly lighted; in a factory or mill the light must be on the machines or work, and must be very good there. In neither case is it necessary to have the whole room as brilliantly lighted as the special points.

In this distribution of light, Mr. Rowland emphasizes the importance of the use of the best portion of the lamp.

"The light from below the lamp—that from the tipped end—is the important and useful light in all practical cases. This is not only true in the specific cases cited, but where large electroliers with many lights are used as well; for in such cases the lamps are usually flared out, with axes at some angle approaching 45°, in which case high candle power from the tipped end and low from the sides of the lamp would contribute to a good even illumination of the room."

The influence of filament form on candle power is a matter on which Mr. Rowland lays much stress. Of the various forms now in use, he shows that the double coil filament, using two coils in one filament, the coils being near the tipped end of the bulb, gives by far the most effective and useful illumination. Tests with 16 candle-power lamps of the same maker, under similar conditions except as to form of filaments, demonstrated that the candle power was very different in various directions, and very differ-

ent in a given direction with difference in type of filament. It is a matter of surprise that so many people have been near the verge of this discovery, but that it has been passed by. A manufacturer of sign lamps advertises special lamps for this purpose with "all the light from the end," but does not seem to have thought that this would be the proper thing for standard lamps!

In discussing what a 16 candle-power lamp really should be, Mr. Rowland takes up the various photometric methods, and after showing their weak points he proceeds:

"What more rational, then, than to measure the lamp's candle-power looking in at the end? It is the light coming from the end which we make use of—which we are interested in. Then this is the light to measure, and that by which the lamp should be rated. Lamps measured thus are as comparable with each other as lamps measured any other way. The apparatus required to make the measurement would be very simple, for no rotating device would be required and the lamp need only be inserted in the socket without any care as to which side comes uppermost when its candle-power is determined, since the candle-power must always be read the same. Thus, readings of different observers would agree without respect to anything involved in the measurement except the standards used and the personal element, which never can be eliminated. Such a radical change of method, however sensible the change, could not be made without the sanction and support of some of the large associations of electrical engineers. In the meantime, however, for eventually this method must certainly come to be used, all *lamp users* should, in addition to a measurement of candle-power in the conventional way to check up the lamps purchased, take a reading of the useful light given out from the tip.

"A 16 candle-power lamp should be one giving 16 candle-power from the tipped end. The horizontal candle-power might be considerably less and be irregular in different directions without altering the real value of the lamp.

"An ideal 16 candle-power lamp would perhaps be one which measures 16 candle-power from the tipped end, had 16 candle-

power as the mean horizontal candle-power, and was of nearly 16 candle-power mean spherical. Such a lamp could be turned into an position in an electrolier and still give an illumination equally as good as before, and as well distributed.

"In most lighting, also, the end of the lamp which has been called the tipped end all along, should be tipless. Hold a piece of white paper below an ordinary tipped lamp hung with the tip down, as it commonly is, and the reason is unnecessary to state. Variations in thickness of glass and shadow cast by the tip make lines of light and shade that spoil all the real value of the light produced.

"Since the making of such lamps as these is doubtless but a choice of filament form and arrangement, let us hope it will not be long until there are some ideal lamps available commercially."

Pumping Engine Economy.

TAKING as a text the tests of the Allis pumping engine at the Chestnut Hill Station, Boston, and the Nordberg engine at Wildwood, Pa., *Engineering News* recently gives a discussion of the question of pumping engine economy which contains a number of points of interest. Each of these engines has beaten all former records of engine performance, when measured by the only accurate method, the thermal-unit basis, and each of them has given a larger return in work done for a given amount of heat furnished by the fuel than was ever before given by a steam engine. The Allis engine gave a duty of 157,002,500 foot pounds per million B. T. U. in the steam furnished by the engine; the Nordberg 162,948,824 foot-pounds. If, however, we consider the economizer in the Allis plant as part of the engine instead of part of the boiler plant, which may fairly be done when we consider that the feed-water is heated in the Nordberg engine with steam taken from the receivers, then we have a duty of 163,925,300 foot-pounds for the Allis engine.

While the results are so nearly alike, the two engines are very different in design and operation. The Allis is a triple-expansion engine, the Nordberg a quadruple. The Allis runs at a speed of 17.2 revolutions per minute, and the Nordberg at 36.5. The Allis engine has one feed-water heater using ex-

haust steam, but relies chiefly on an economizer to heat its feed water; while the Nordberg has five heaters, one supplied with exhaust steam and the other four from the low-pressure cylinder and the three receivers. The Allis engine expands its steam about 42 times and the Nordberg about 24.

The coal consumption of the Nordberg engine plant is not given, but in the case of the Allis engine it is given as 1.062 pounds per i. h. p. hour. This appears to be the lowest figure obtained by any plant. It is nearly down to gas-engine practice with gas producers using anthracite coal or coke, and lower than the results for gas engines using gas from bituminous coal.

In suggesting where further economies might be effected, the writer shows that the substitution of a better coal might result in reducing the coal figure to 1 pound per horse-power-hour. Again, the economizer might be rendered more efficient. The figures of its performance show that it utilized only about 60 per cent. of the heat furnished to it. There was a further loss of heat during the test, due to cooling the drips from the separator, low-pressure jacket, and receiver, all of which might be saved by pumping the hot drips directly to the boiler.

"A still further reduction may be made by high superheating of the steam, which is now becoming quite common in Europe, but which American engine builders seem rather slow to adopt. With this improvement added, the fuel consumption of the plant may be brought down to, say, 0.90 pound per i. h. p. hour, and the duty raised to about 190 millions. All this without any change in the engine itself. It is not improbable, however, that the proportions or design of either the Allis or the Nordberg engine might be changed with advantage. There is a great difference between a triple expansion engine expanding 42 times, and a quadruple engine expanding only 24 times; and it is quite possible that a triple expanding 36 times and a quadruple expanding 42 times would each give a better record than the present engines."

It is well known, however, that the engine which uses the least fuel is not always the engine which uses the least money. The practical question in most cases where a

large pumping engine is to be installed is not how great fuel economy can we reach, but how economical an engine will it pay to install? "Each case must be considered by itself, and in order to determine the most economical engine to install in a given place, the first cost of engines and boilers, the number of hours per year during which the engines are run, the rate of interest and depreciation, the cost of repairs, the cost of attendance, and the cost of fuel must all be taken into account."

In order to show the manner in which the various factors affect the general result, different prices for coal, and different rates of wages are assumed, and the results tabulated, the whole forming a very instructive exhibit of matters too often neglected by the theoretical engineer.

Moulding by Machinery.

THE use of moulding machines in the foundry is one which has had much discussion both in manufacturing and labor circles, and hence the paper of Mr. E. H. Mumford, recently presented before the Foundrymen's Association, is of more than usual interest.

Naturally there is more or less objection among skilled moulders at the advent of machines which enabled laborers to earn almost moulders' wages, and the old, old problem of the introduction of labor-saving machines is awakened anew with the improvements and use of such machines. There is no doubt that the moulding machine has come to stay, and that the real thing is to show the moulder that it is his friend and not his enemy, and that he will be better off with than without it.

Mr. Mumford states the old argument in favor of labor-saving machinery, but in such a concise and effective manner that it will well bear repeating.

"The general introduction of labor-saving machinery in the world of manufacture, while it has undoubtedly the (at least temporary) effect of displacing labor in the general field which it enters, yet increases rapidly the number employed in two other fields, namely: That where the machines are built and that which uses no machinery at all. That is, anything which facilitates the use of labor-saving machinery in general, as in the textile and agricultural in-

dustries—which the moulding machine obviously does, increases the number of men employed in making these machines. As the moulder, most naturally, is interested in the future of his trade, he should, therefore, do everything he can to encourage machine building in general, and nothing offers a better opportunity than leaving the moulding machine absolutely untrammelled in its natural progress with unskilled labor."

The present position of the Iron Moulders' Union is that the members should be allowed to develop the best possibilities of the machine and thus be able to "control" it. The best possibilities of the machine, like all other machines, will be developed by those who own them and who employ the men who operate them. It would be as useless for anyone to attempt to prevent the introduction of such machines as it would have been for machinists of earlier days to have prevented the introduction of the slide rest because it could be operated by men who had not the old-time skill with the hand tool. As Mr. Mumford well says: "The control of the moulding machine will never pass from the hands of the evolutionary destiny of the manufacturing world to either the moulder, the builder of the moulding machine, or its owner."

It would be an interesting matter to have the exact meaning of the term "skilled labor" examined at various periods of history, for it would assuredly be found that what was skilled at one period would be very crude at another. The real skill is not that of the mechanic, but of the man of genius, the artist, whose individuality is stamped upon his own work, a skill which he can only impart to those who, like himself, have the heaven sent gift of genius; or the skill of the mechanical genius, who can devise methods and apparatus for performing work which makes the skill of preceding times and men clumsy and crude by comparison, and sends tools and methods to the shelves of the mechanical museum and the pages of historical books.

Mr. Mumford enunciates five prominent facts, which show that the tardy trade of the moulder is gradually rising to the plane of the other departments of the machine works, despite attempts to retard progress by "controlling" machines and methods:

1. Moulding machines have entered upon a field of work in which they have proved their usefulness and economy, and in which they are destined to remain instruments of progress.

2. Machines dispense with some of the skill necessary to the moulder by the method of their working and render more of this skill unnecessary by avoiding some of the difficulties hand moulding introduces, such as mending broken corners, etc. They may therefore be successfully worked by unskilled laborers.

3. While laborers are perfectly well able to make machines profitable, in doing this they generally earn almost moulder's wages, when paid by the piece or when putting up a large day's work, and it is therefore possible for a moulder to do as well for the owner of the machine and for himself as the laborer does, if he will work as hard.

4. The moulder will not do as large a day's work as the laborer on a moulding machine for the same amount of money, and is therefore an expense to the owner of the machine he runs, similar to what would be the case if moulders were to charge the cupola, or run the cranes.

5. There is work enough for both the machine and moulder; and the machine, taking as it does, the repetition work, relieves him of the monotony which the general introduction of machines is accused of forcing on the wage-earning class as a whole, and owing to the speed and cheapness with which the machine turns out small parts, more of the larger and more intricate portions of machines are called for from the moulder.

American Pig-Iron Production.

THE commanding position which America has held in the pig iron market during 1899-1900, and the gradual return from the boom to normal conditions lends great value to the editorial résumé of the whole subject in a recent editorial in *Engineering News*. This paper has taken the weekly reports, furnished by the *Iron Age*, and by plotting them in the form of curves has enabled a general review of the production of the year to be very clearly seen. The curves include the latter portion of 1897, the whole of 1898 and 1899, and the first nine months of 1900, thus showing the in-

ception, growth, and recovery of the boom. The curves show the production of pig iron in gross tons per week, the number of furnaces in blast, and the prices, and from the beginning of 1899, the stocks of pig iron at furnaces.

It is difficult, without the diagrams, to show the fluctuations in products and prices, but it is interesting to observe that the output rose from 165,000 tons, in August, 1897, to 234,000 tons, in March, 1898, and to 298,000 tons in February, 1900. The prices in the meantime jumped from \$9.35 to \$10.40, to \$24.90, but by September, 1900, the production had dropped to 223,000 tons, and the price to \$14 per ton.

"Not only has production caught up to, and surpassed the demand, but the available furnace capacity is now far beyond any possible demand for the near future. It is now nearly eight months since the furnaces gave their maximum production of 298,000 tons per week, but during all this time many large furnaces have been under construction, and will be ready to blow in when the market warrants it. In the issue of *Engineering News* for November 9, 1899, there was published a list of nineteen large furnaces then building or projected, with an aggregate capacity estimated at 2,600,000 tons per annum, or about 20 per cent. of the then annual rate of production of the country.

"What of the future? Prices have now receded from the maximum of 150 per cent. above what may be called the normal price in ante-boom times of \$10 per ton, to 40 per cent. above. Will they stay where they are for a while, or will they soon go lower? Judging from the state of the demand, and the accumulation of stocks, they should go to a much lower point than they have yet reached; but there are reasons for a contrary course. The cost of labor in all branches of the industry, and of freights by railroad and lake, is higher than it was in 1898, and this cost is not likely to be reduced at the present time, when the general business of the country is prospering. The slackened demand is not a normal demand; it is the demand of a waiting market, of customers afraid of a Presidential election, and of still lower prices. When buyers make up their minds that prices have touched bottom, buying will increase rap-

idly, and a steady and very large business will be done at reasonably steady prices. The boom is over; the reaction is come, but it will be of short duration, and the rebound will soon carry us back to good business conditions."

An interesting comparison is made with former booms, especially that of 1879-1880. Unlike the former boom, the present one has not shown the craze for speculation prevalent in 1879, when "privileges," "puts and calls," etc., on pig iron were dealt in by people who knew nothing whatever about pig iron, and when many fortunes were made and as many more lost by this form of gambling.

"The boom of 1899-1900 happily escaped this speculative feature, and the result was a steady market at maximum prices for six months, instead of a feverish market for only two months, as in 1880. There being less fever, the period of recovery has also been calmer. There have been no failures in the iron trade, and no great excitement.

"The whole history of the boom shows that it was only what might have been expected of a industry upon which general manufactures are so dependent, and which requires so much time to respond to a large demand. When it is considered how large an operation the construction and operation of a new blast furnace plant is, and when it is seen that the number of furnaces in the United States increased from 146 in the middle of 1897 to 293 in the middle of 1900, the reason for the rapid increase in price, and the steady maintenance, will be understood. It is indeed a healthy sign when such a great industry can respond to such a demand and maintain a sound business condition, ready either for steady requirements or for a great and rapid demand.

The Niagara Gorge Railway.

WHEN it was proposed to construct an electric railway in the gorge of the Niagara river, many persons felt that it would be a desecration of that magnificent piece of natural scenery, but now that five years of successful operation have elapsed, the paper of Mr. George A. Ricker, in a recent issue of the *Street Railway Journal*, is especially valuable as showing both the technical and æsthetical success of the work.

So far from being a defacement to the scenery, the gorge railway, like many of the Alpine rack railroads, is such an insignificant portion of the view that no appreciable impression is made by the tracks which hug the shelf at the foot of the great cliffs, winding their way beside the waters like toy tracks of children, with cars running slowly up and down, and looking like plaything trains.

During the construction of the road some landslides naturally followed the excavation of the talus, and bare spots were produced which were unsightly for a time. These are now fully covered with new vegetation, and any feeling that is had for the effect of the presence of the tracks and cars is fully overbalanced by the pleasure of the eager throngs that view the splendid panorama of the gorge from the vantage ground of the new road. Before the railroad was built but little could be seen of the wonderful spectacle. At a few points only could visitors get narrow glimpses of the tumbling waters, from stairways and crevices in the cliffs; now the whole river from the falls to Lewiston can be seen and enjoyed.

"Probably no more difficult railroad survey was ever attempted than this. The slopes, which from the uplands seem to be covered with soft verdure, and to present no great obstacles to progress, were found to be at close range almost impenetrable jungles of underbrush. Shrubs and trees in countless varieties were intertwined and bound together by the wild grape vines, grown to such density and strength as only the wild grape can, when undisturbed for many years. Much trouble was experienced in the insecure footing, as nicely balanced rocks of great size would roll down the slopes, crushing everything before, from the weight of a man climbing over them. The work of the survey was hazardous in the extreme, for not only was the vegetation dense and the footing insecure on the talus, but for a distance of about one-half mile below the railroad bridges, nearly vertical cliffs extended from the Highlands to the rapids below. At several points in this section men from the engineer corps were lowered over the cliffs and flags placed on projecting ledges where they might be seen from the top of the bank on the Canadian side. Base lines were established on Can-

ada's side of the river, from which the flags were located by triangulation. Beyond this section, and continuing to Lewiston, the line was run following the curving bank of the river, and as nearly as possible 20 feet above the average water level."

This difficult survey work was naturally followed by difficult construction, and Mr. Ricker tells of many troubles which were experienced. No attempt was made at mathematical alignment, and the road bed follows the irregular outline of the natural slope. None of the curves are at all sharp for the slow rate of speed required by the schedule, and all that are less than 300 feet radius are protected by guard rails. In many places the road runs on a shelf blasted in the cliffs, and in others upon what is described as "enrockment." The whole is an example of difficult work well executed and thoroughly adapted to the unique conditions existing.

"Operation of the Niagara gorge railway, is continued from the first of May of each year to the first of March of the following year. March and April are the only months when the loose material from the cliffs falls upon the slopes of the talus. This is, of course, when the frost is coming out, and small stones which have been wedged out by the ice are loosened. Since beginning operation of the road in 1895 to the present time, no passenger or employee has ever received injury from falling rocks. With due care, and such is most certainly maintained by the present management, the maintenance of this railroad need not be excessively expensive, and that the same safety of operation can be obtained as is secured on any mountain railroad.

"Since the acquisition of the railroad at the top of the bank on the Canadian side by the International Traction Company and the reconstruction of the Suspension Bridge at Lewiston, a belt line has been in operation, over which cars of the Niagara Gorge Railroad Company pass, starting from Niagara Falls, and going to Lewiston by both railroads, making the trip down the Canadian side across the Suspension Bridge and up the Gorge; and also in the reverse direction. The extraordinary beauty of the scenery from the commanding heights on her Majesty's side of the river, combined with the grandeur and wondrous effects of

the rapids, which Hawthorne describes as 'an impetuous river of snow,' affords to the traveler an experience which is at once unique and impressive beyond power of words to describe.

"A new feature has been added to the attractions of the Gorge by illumination of the rapids at night. Trains are made up at the Falls, and run to the rapids, where an hour or more can be spent in contemplation of the beautiful spectacle. The lamps are hidden from view, and their rays projected over the waves by reflectors, so arranged that the illumination is most effective. In addition to the arcs, a large searchlight, mounted on a flat car, takes position some distance below the observation platforms, while its powerful beams are thrown against the waters and screens of green and yellow interposed, producing most beautiful effects. The roar of the waters against the walls of the Gorge, the depth of the canyon in the darkness of the night and the frowning cliffs above produce upon the onlooker a feeling of awe and fascination."

The Mouth of the Mississippi.

THE Mississippi river has always been a problem for the engineer, and there is every reason to believe that it will furnish him continual occupation for the future. The mouth, especially, or rather the mouths, have been the object of continual effort and activity, since the necessity of maintaining a navigable channel to the Gulf of Mexico is imperative. The famous jetties of Captain Eads provided a channel at the South

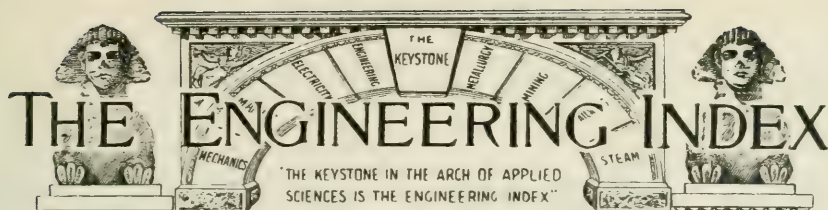
Pass, and now there is a projected improvement of the Southwest Pass, discussed very fully and ably by Mr. William Starling in a recent issue of *Engineering News*.

Here it is proposed to provide a channel of 35 feet depth, and from a report made in 1898, by a board of engineers to Congress, the practicability of the plan was shown.

The plans provide for a combination of jetties and dredging, and with the experience had at the South Pass with the conditions to be met.

It is impossible here to give even an abstract of the very exhaustive paper of Mr. Starling, but it will be of interest to know that the cost of the projected works is estimated at \$6,000,000, of which about \$1,500,000 is for unforeseen contingencies, an indication of the uncertain character of such work.

The estimate of Mr. Corthell, that by 1948 the twenty largest steamships will average 1,000 feet long, 100 feet broad, and 43 feet deep, with a draught of 33 feet, shows how necessary it is for ports which desire to maintain their commerce to begin in time to deepen their entrances. Even in 1903 it is expected that vessels of 31 feet draught may be expected, and not only harbors, but docks as well, should be prepared to receive vessels of such dimensions. New York already has a channel 35 feet deep and 1,000 feet wide, and has under consideration one of 40 feet depth and 2,000 feet width, so that New Orleans is none too soon in the attempt to meet the coming conditions.



The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language*; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of \$1.00; G, of \$1.20; and H, of \$1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for \$2.00, thirty-three for \$5, and one hundred for \$15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of *THE ENGINEERING MAGAZINE* at 10 cts. per month, or \$1.00 a year; to non-subscribers, 25 cts. per month, or \$3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: *Ill*—Illustrated; *W*—Words; *Anon*—Anonymous.

American Architect. *w*. Boston, U. S. A.
 American Electrician. *m*. New York.
 Am. Engineer and Railroad Journal. *m*. New York.
 American Gas Light Journal. *w*. New York.
 American Geologist. *m*. Minneapolis, U. S. A.
 American JI. of Science. *m*. New Haven, U. S. A.
 American Machinist. *w*. New York.
 Am. Manufacturer and Iron World. *w*. Pittsburg, U. S. A.
 American Shipbuilder. *w*. New York.
 Annales des Pontes et Chaussées. *m*. Paris.
 Architect. *w*. London.
 Architectural Record. *qr*. New York.
 Architectural Review. *s-q*. Boston, U. S. A.
 Architect's and Builder's Magazine. *m*. New York.
 Australian Mining Standard. *w*. Sydney.

Automobile Magazine. *m*. New York.
 Automotor & Horseless Vehicle JI. *m*. London.
 Brick Builder. *m*. Boston, U. S. A.
 British Architect. *w*. London.
 Brit. Columbia Mining Rec. *m*. Victoria, B. C.
 Builder. *w*. London.
 Bulletin Am. Iron and Steel Asso. *w*. Philadelphia, U. S. A.
 Bulletin de la Société d'Encouragement. *m*. Paris.
 Bulletin of Dept. of Labor. *b-m*. Washington.
 Bulletin of the Univ. of Wisconsin, Madison, U. S. A.
 Bull. Int. Railway Congress. *m*. Brussels.
 California Architect. *m*. San Francisco, U. S. A.
 Canadian Architect. *m*. Toronto.

- Canadian Electrical News. *m.* Toronto.
 Canadian Engineer. *m.* Montreal.
 Canadian Mining Review. *m.* Ottawa.
 Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
 Colliery Guardian. *w.* London.
 Compressed Air. *m.* New York.
 Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
 Consular Reports. *m.* Washington.
 Contemporary Review. *m.* London.
 Deutsche Bauzeitung. *b-w.* Berlin.
 Domestic Engineering. *m.* Chicago.
 Eclairage Electrique. *w.* Paris.
 Electrical Engineer. *w.* London.
 Electrical Review. *w.* London.
 Electrical Review. *w.* New York.
 Electrical World and Engineer. *w.* New York.
 Electrician. *w.* London.
 Electricien. *w.* Paris.
 Electricity. *w.* London.
 Electricity. *w.* New York.
 Elektrizität. *b-w.* Leipzig.
 Elektrochemische Zeitschrift. *m.* Berlin.
 Elektrotechnische Zeitschrift. *w.* Berlin.
 Elettricita. *w.* Milan.
 Engineer. *w.* London.
 Engineer. *s-m.* Cleveland, U. S. A.
 Engineers' Gazette. *m.* London.
 Engineering. *w.* London.
 Engineering and Mining Journal. *w.* New York.
 Engineering Magazine. *m.* New York & London.
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
 Fire and Water. *w.* New York.
 Foundry. *m.* Detroit.
 Gas Engineers' Mag. *m.* Birmingham.
 Gas World. *w.* London.
 Génie Civil. *w.* Paris.
 Gesundheits-Ingenieur. *s-m.* München.
 Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
 Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
 Horseless Age. *m.* New York.
 Ice and Refrigeration. *m.* New York.
 Indian and Eastern Engineer. *m.* Calcutta.
 Iron Age. *w.* New York.
 Iron and Coal Trades Review. *w.* London.
 Iron & Steel Trades Journal. *w.* London.
 Iron Trade Review. *w.* Cleveland.
 Journal Assn. Eng. Societies. *m.* Philadelphia, U. S. A.
 Journal of Electricity. *m.* San Francisco.
 Journal Franklin Institute. *m.* Philadelphia.
 Journal of Gas Lighting. *w.* London.
 Journal Royal Inst. of Brit. Arch. *s-gr.* London.
 Journal of Sanitary Institute. *qr.* London.
 Journal of the Society of Arts. *w.* London.
 Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
 Journal Western Soc. of Eng. *b-m.* Chicago.
 Journal of Worcester Poly. Inst., Worcester, Mass.
 L'Energie Electrique. *w.* Paris.
 Locomotive. *m.* Hartford, U. S. A.
 Locomotive Engineering. *m.* New York.
 Machinery. *m.* London.
 Machinery. *m.* New York.
 Marine Engineering. *m.* New York.
 Marine Review. *w.* Cleveland, U. S. A.
 Meta! Worker. *w.* New York.
 Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
 Mines and Minerals. *m.* Scranton, U. S. A.
 Mining and Sci. Press. *w.* San Francisco, U. S. A.
 Mining Reporter. *w.* Denver, U. S. A.
 Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
 Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
 Modern Machinery. *m.* Chicago.
 Moniteur des Architects. *m.* Paris.
 Moniteur Industriel. *w.* Paris.
 Municipal Engineering. *m.* Indianapolis, U. S. A.
 National Builder. *m.* Chicago.
 Nature. *w.* London.
 Nature. *w.* Paris.
 Nautical Gazette. *w.* New York.
 New Zealand Mines Record. *m.* Wellington.
 Nineteenth Century. *m.* London.
 North American Review. *m.* New York.
 Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
 Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
 Ores and Metals. *w.* Denver, U. S. A.
 Plumber and Decorator. *m.* London.
 Popular Science Monthly. *m.* New York.
 Power. *m.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Soc. Civil Engineers. *m.* New York.
 Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
 Proceedings St. Louis R'way Club. *m.* St. Louis, U. S. A.
 Progressive Age. *s-m.* New York.
 Railroad Car Journal. *m.* New York.
 Railroad Gazette. *w.* New York.
 Railway Age. *w.* Chicago.
 Railway & Engineering Review. *w.* Chicago.
 Review of Reviews. *m.* London & New York.
 Revue de Mécanique. *m.* Paris.
 Revue Gen des Chemins de Fer. *m.* Paris.
 Revue Technique. *b-m.* Paris.
 Revue Universelle des Mines. *m.* Liège.
 Rivista Marittima. *m.* Rome.
 Sanitary Plumber. *s-m.* New York.
 Schweizerische Bauzeitung. *w.* Zürich.
 Scientific American. *w.* New York.
 Scientific Am. Supplement. *w.* New York.
 Stahl und Eisen. *s-m.* Düsseldorf.
 Stevens' Institute Indicator. *qr.* Hoboken, U. S. A.
 Stone. *m.* New York.
 Street Railway Journal. *m.* New York.
 Street Railway Review. *m.* Chicago.
 Telephone Magazine. *m.* Chicago.
 Tramway & Railway World. *m.* London.
 Trans. Am. Ins. Electrical Eng. *m.* New York.
 Trans. Am. Ins. of Mining Eng. New York.
 Trans. Am. Soc. of Civil Eng. *m.* New York.
 Trans. Am. Soc. of Heat & Ven. Eng. New York.
 Trans. Am. Soc. Mech. Engineers. New York.
 Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
 Transport. *w.* London.
 Western Electrician. *w.* Chicago.
 Wiener Bauindustrie Zeitung. *w.* Vienna.
 Yacht. *w.* Paris.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
 Zeitschrift für Elektrochemie. *w.* Halle a. S.
 Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Baths.

The Francis Joseph Jubilee Baths at Reichenberg (Kaiser Franz Josefs Jubiläumsbad in Reichenberg). P. P. Brang. With elevation, plans and section of these fine new public baths in Austria. 2000 w. Zeitschr Oesterr Ing u Arch Ver—Aug. 10, 1900. No. 36619 B.

Chimneys.

Points on Chimneys. J. L. Bixby, Jr. Considers draft pressure, gauges, materials, etc., in part first. Ill. 2500 w. Met Work—Sept. 15, 1900. Serial. 1st part. No. 36396.

Earthquake-Proof.

The Construction of Earthquake-Proof Modern Buildings. Report of Earthquake Investigation Committee, Japan. Ill. 1400 w. Am Arch—Sept. 1, 1900. No. 36254.

Exposition.

The Schneider Pavilion at Paris. An illustrated description showing the numerous conditions that had to be fulfilled and the way the work was carried out. 3000 w. Engng—Aug. 24, 1900. No. 36238 A.

Fire Protection.

Fire Hazards. H. de B. Parsons. Discussing the effect of design and construction on the risk of fire, and the materials that best resist a conflagration. 6500 w. Jour Fr Inst—Sept., 1900. No. 36288 D.

Foundations.

The Manhattan Railway Power-House Foundations. Illustrated description of the very heavy concrete foundations for a 431 x 204-ft. station to develop about 100,000 H. P. 2000 w. Eng Rec—Sept. 8, 1900. No. 36306.

Ice-Making.

Building for a Large Ice-Making Plant.

Illustrated description of a 5-story structure about 200 ft. square, consisting of a machine house, freezing house and boiler house, and containing many unusual details in the steel work. The coal and ash pockets are described very fully. 2800 w. Eng Rec—Sept. 8, 1900. No. 36305.

Underground Chambers.

The Construction of Moisture-Proof Underground Chambers. L. R. Grabill. Discusses methods and gives plan and description of an underground dynamo-room of moisture-proof construction. 1500 w. Eng News—Sept. 6, 1900. No. 36319.

HEATING AND VENTILATION.

Club House.

Lighting, Heating and Ventilating a Club House. Illustrated description of changes made at the Whist Club of New York. 2000 w. Met Work—Sept. 8, 1900. No. 36300.

Dormitories.

Ventilation and Heating of the University of Pennsylvania Dormitories. Illustrated description of the methods of heating a large number of small rooms and ventilating them by the plenum system. 1800 w. Eng Rec—Sept. 8, 1900. No. 36307.

Moisture.

Moisture in the Air of Rooms. J. H. Kinealy. From *Heating, Ventilating and Sanitary Plumbing*. The sources of moisture, the amount, etc., are discussed. 3800 w. Pro Age—Sept. 1, 1900. No. 36210.

Steam Heating.

Pressure Regulator, on the Eggert System (Druckregler, System Eggert). An illustrated description of a pressure regulator for steam-heating plants. 1200 w. Gesundh Ing—July 15, 1900. No. 36559 B.

CIVIL ENGINEERING

BRIDGES.

Alexander III.

The Cast-Steel Construction of the Alexander III. Bridge in Paris (Die Stahlformguss-Constructionen der Alexanderbrücke in Paris). Inspector Frahm. Giving especial attention to the moulding and casting of the steel voussoirs. Two articles. 7500 w. Stahl und Eisen—Sept. 1, 15, 1900. No. 36649 each D.

Arches.

Arch Construction for Railroads. From a paper by J. W. Rollins, Jr., before the New England Railroad Club, with illustrations. Serial. 1st part. 1300 w. Ry & Eng Rev—Sept. 22, 1900. No. 36831.

Bracing.

Diagonal Bracing Over the Turntable in Swing Bridges. Malverd A. Howe. Mathematical discussion of the stresses in

a case of balanced loading. 1000 w. R R Gaz—Aug. 31, 1900. No. 36184.

Drawbridge.

The Maumee River Drawbridge. Illustrated description of a bridge having a center pivot of unusual design and special end lifting devices. 1000 w. Eng Rec—Sept. 8, 1900. No. 36303.

Lattice.

Shipping and Erecting a Complete 130-Foot Railroad Span. Illustrated description of the method of shipping a single track lattice girder span with trusses 14 ft. 9 in. deep and 10 ft. apart. 1000 w. Eng Rec—Sept. 1, 1900. No. 36197.

Moselle.

The Bridge Over the Moselle Between Trarbach and Traben (Die Moselbrücke bei Trarbach-Traben). A very completely illustrated account of the new highway bridge over the Moselle. Five braced bowstring trusses of 54 to 64 metres span. Two articles. 3500 w. Glaser's Annalen—Sept. 1, 15, 1900. No. 36656 each D.

Niagara.

Rebuilding Niagara's Reservation Bridges. A general account of the new concrete bridges between the mainland, Green Island and Goat Island, with illustrations of preliminary construction. 700 w. Sci Am—Sept. 22, 1900. No. 36583.

Norval's Pont.

The Reconstruction of Norval's Pont Bridge. Some good illustrations of the bridge before and after reconstruction. 250 w. Engng—Sept. 7, 1900. No. 36453 A.

Paris Exhibition.

Railways and Bridges at the Paris Exhibition. Brief descriptions of interesting engineering construction. 4000 w. Builder—Aug. 25, 1900. No. 36233 A.

Pontoon.

Pontoon Swing Bridges Over the River Weaver, at Northwich, England. John A. Saner. Abstract of a paper before the Institution of Civil Engineers, describing a swing span supported upon a circular steel pontoon, with various interesting details. 1 plate. 5000 w. Eng News—Sept. 20, 1900. No. 36546.

Viaur Viaduct.

The 721-ft. Three-Hinged Steel Arch Railway Bridge Across the River Viaur, France. Illustrated detailed description of one of the most notable metal arch bridges of recent years. 4000 w. Eng News—Sept. 6, 1900. No. 36316.

CONSTRUCTION.

Arches.

Notes on Foundation Arches (Einiges über Grundbogen). A. Francke. A mathematical study of inverted arches as used for masonry foundations. 2000 w.

Schweizerische Bauzeitung—Aug. 25, 1900. No. 36666 B.

Foundations.

A Novel French Method of Making Foundations in Soft Ground. A description of a method invented by Messrs. Dulac and Ducloux, in which a hole is driven in soft ground by a falling weight, and filled in with hard material. 1100 w. Eng News—Sept. 27, 1900. No. 36844.

Foundations of the Alliance Building. Illustrated description of the method of sinking 100 pneumatic caissons for the foundations of a building covering 27,000 sq. ft. ground area; also illustrates the steel grillages and wind bracing. 2700 w. Eng Rec—Sept. 22, 1900. No. 36709.

Reinforced Concrete.

Reservoir of 3,000 Cubic Metres Capacity in Reinforced Concrete (Reservoir de 3,000 Mètres Cubes de Capacité en Ciment Armé). Illustrated description of a reservoir at Waalheim, in Belgium, constructed with concrete reinforced by expanded metal. Full details are given. 1200 w. Revue Technique—Sept. 10, 1900. No. 36616 D.

Theory and Applications of Concrete-Iron Construction (Anwendung und Theorie der Betoneisen Konstruktionen). Josef Rosshänder. A general examination of the various methods of reinforcing concrete by means of imbedded metal. Serial. Part I. 1800 w. Schweizerische Bauzeitung—Sept. 8, 1900. No. 36667 B.

The Use of Expanded Metal in Concrete Construction. From a paper before the British Association by A. T. Walmsley, giving theoretical considerations and also the results of trials. 1800 w. Gas Wld—Sept. 15, 1900. No. 36792 A.

HYDRAULIC AND WATER SUPPLY.

Canal.

The Completion of the Marne-Saone Canal (L'Achèvement du Canal de la Marne à la Saone). G. Leugny. With map and sections of various portions of the canal, and a table showing the shortening in route effected. 3500 w. Revue Technique—Aug. 10, 1900. No. 36612 D.

Canal Haulage.

See Electrical Engineering, Power Applications.

Causeway.

Hydraulic Causeway Construction. Describes a long road over the marshes of Jamaica Bay, built up with sand and mud obtained by hydraulic dredging and deposited between banks of turf. 1900 w. Eng Rec—Sept. 22, 1900. No. 36706.

Coast Protection.

Sea Coast Destruction and Littoral Drift. W. H. Wheeler. States the conditions that have caused the present state

of the cliffs and coasts, and the conditions under which the material is drifted along the shore, illustrating by a study of the coast of the south-west of England. 3400 w. *Nature*—Aug. 23, 1900. No. 36227 A.

Columbus, O.

Columbus and Its Water-Works. Historical account, with illustrations of pumping station. 1600 w. *Fire & Water*—Sept. 1, 1900. No. 36266.

Dam.

The Wachusett Dam for the Metropolitan Water Supply, Boston, Mass. Alfred D. Flinn. An elaborately illustrated description of the proposed great masonry dam, with selected passages from the specifications. 1 plate. 8000 w. *Eng News*—Sept. 13, 1900. No. 36419.

The Wachusett Dam. Illustrated description of a masonry dam of unusually heavy section, over 200 ft. high, for the Metropolitan Water Board of Massachusetts. The first part describes the site, the character of the masonry and the gate chambers. 3900 w. *Eng Rec*—Sept. 8, 1900. Serial. 1st part. No. 36302.

Dredging.

Dredges (Les Dragues). R. Masse. The first instalment of a treatise on dredging machinery. Part first treats of suction dredges. 3500 w. *Revue de Mécanique*—Aug., 1900. No. 36641 H.

Dredge for Calcutta. Describes the first of four dredges for use at the Kidderpore docks, Calcutta, and in improving the canal between the Baltic Sea and the Volga River. 1000 w. *U. S. Cons Repts*, No. 833—Sept. 14, 1900. No. 36389 D.

Hopper Dredger "La Puissante." A well illustrated description of the largest dredger of the stern-well bucket type, built in England for the Suez Canal Company. 900 w. *Engr, Lond*—Sept. 7, 1900. No. 36464 A.

Hydraulic Hopper Dredges for the East Channel, New York Harbor. Illustrated description of the "Thomas" and "Mills," each 300 feet long, 52½ feet wide and carrying 7,000 tons. 1500 w. *Eng Rec*—Sept. 22, 1900. No. 36705.

Dry Dock.

Flooding of the New Dry Dock Excavation at the Boston Navy Yard. Frank O. Maxson. Illustrated description of the sliding of a large area in consequence of excavation behind the coffer dam. 2800 w. *Eng Rec*—Sept. 22, 1900. No. 36707.

Filters.

On American Filters and Filtration Methods, Particularly on the Rapid Filter (Ueber Amerikanische Filter und Filter-Methoden, insbesondere über die Schnell-Wasserfilter). Wm. Paul Gerhard. A general review of American methods of filtering water for city purposes on a large

scale. Serial. 1st part. 1800 w. *Gesundh Ing*—July 15, 1900. No. 36557 B.

Flow of Water.

Experiments on the Flow of Water Over Dams. Abstract of a graduation thesis by A. H. Greenwood, L. S. Oakes and J. L. Sanborn, at the Thayer School of Civil Engineering, giving the results of experiments, with models of several well-known dams. Illustrated. 2900 w. *Eng News*—Sept. 27, 1900. No. 36843.

Gatehouse.

Spruce Lake Gatehouse. Illustrated description of a gatehouse at St. John, N. B. 1200 w. *Fire & Water*—Sept. 8, 1900. No. 36352.

German Waterways.

The Interior Navigation of Germany (La Navigation Intérieure de l'Allemagne). A review of the internal waterway system of Germany. 1100 w. *Moniteur Industriel*—July 14, 1900. No. 36837 E.

Holyoke.

The Water Power at Holyoke, Massachusetts. Horatio A. Foster. Paper before the Engineers' Society of Western New York, giving an illustrated account, historical, technical and financial, of this water power on the Connecticut River. 5400 w. *Jour Assn of Engng Socs*—Aug., 1900. No. 36531 C.

Irrigation.

Irrigation in Idaho. Brief review of the work that has been done, with illustrations. 800 w. *Sci Am*—Sept. 8, 1900. No. 36313.

Lighthouses.

French Lighthouses at the Paris Exposition (Les Phares Français à l'Exposition de 1900). A review of French modern practice as illustrated at the Exposition. 1100 w. *Moniteur Industriel*—July 28, 1900. No. 36839 E.

Lights on Lake Erie. An interesting communication from Col. Wm. Anderson, of Ottawa, relative to a new plan of lighting Pelee Passage. 700 w. *Marine Rev*—Aug. 30, 1900. No. 36207.

Mississippi.

High-Water Protection Methods on Lower Mississippi River. Wm. J. Hardee. Paper before the Louisiana Engineering Society, containing a discussion of the levee system and suggestions for improvements. 9500 w. *Jour Assn of Engng Socs*—Aug., 1900. No. 36532 C.

Reservoirs and the Control of the Lower Mississippi. James A. Seddon. A consideration of drainage systems and their combinations, with their problems, giving a summary of twenty years' experience. Also discussion. Plates. 31000 w. *Jour W. Soc of Engs*—Aug., 1900. No. 36292 D.

The Problem at the Mouth of the Mississippi River. Advocates the improvement of Southwest Pass rather than South Pass. 1200 w. Eng Rec—Sept. 15, 1900. No. 36414.

New England Association.

Annual Convention of the New England Water-Works Association. Abstracts of papers read at Rutland, Vt. 1500 w. Eng News—Sept. 27, 1900. No. 36853.

Ozonization.

The Ozonization of Water. Geo. A. Soper. Paper giving results of practical experience, with discussion. 7000 w. Jour N Eng Water Works Assn—Sept., 1900. No. 36533 D.

Pipe.

A Few Notes on Cast-Iron Pipe. F. C. Coffin. Paper giving various practical points, with illustration of a joint. 1600 w. Jour N Eng Water Works Assn—Sept., 1900. No. 36536 D.

Cement-Lined Service Pipes. F. F. Forbes. Paper giving results of practical experience, with discussion. 5000 w. Jour N Eng Water Works Assn—Sept., 1900. No. 36537 D.

Pipe Joints.

Wooden Joints in Cast-Iron Water Mains. William Murdoch. Short paper, giving an account of experience at St. John, N. B. 1 plate. 1200 w. Jour N Eng Water Works Assn—Sept., 1900. No. 36535 D.

Reservoirs.

Storage Reservoirs in England (Stauweiher in England). Thomas Hofer. Notes upon English reservoirs made during a journey of inspection. 4000 w. 2 plates. Oesterr Monatschr f d Oeffentl Baudienst—Sept., 1900. No. 36660 D.

The Construction of the Fells Reservoir for the Metropolitan Water Works. John L. Haward. A well illustrated paper giving an account of this part of the works for supplying Boston and vicinity with water. 4400 w. Jour N Eng Water Works Assn—Sept., 1900. No. 36534 D.

River Improvement.

The Improvement of Non-Tidal Rivers by Regulation. Abstract of report by G. T. Nelles on the improvement of a river without sufficient probable traffic to warrant its canalization. 4500 w. Eng Rec—Sept. 1, 1900. No. 36205.

Screens.

Screens and Screen Lifters; Metropolitan Water-Works, Boston and Vicinity. Chas. W. Sherman. An illustrated description of a standard design of screen, and a mechanical device for handling screens. 500 w. Eng News—Sept. 27, 1900. No. 36852.

Submerged Main.

Repairing a Submerged Water Main. Describes methods used in Cleveland, O., to patch riveted steel mains injured by anchors. 600 w. Eng Rec—Sept. 22, 1900. No. 36713.

Water Power.

Power Development of the Drainage Canal at Joliet. An illustrated description of an 8,000-horse-power water and electric power plant at a dam in the Chicago Drainage Canal. 2500 w. W Elec'n—Sept. 22, 1900. No. 36745.

Water Supply.

San Francisco's Water Supply. Engravings giving a good idea of the system, which furnishes an abundant supply, with brief explanation of the peculiar conditions. 900 w. Min & Sci Pr—Aug. 25, 1900. No. 36193.

The Bradford Water Works. James Watson. Paper before the British Association on water supply, with a description of the Bradford water works. 6000 w. Engng—Sept. 14, 1900. No. 36598 A.

Water Supply Progress at Dayton. Extracts from the annual report showing constant progress. 1500 w. Fire & Water—Sept. 1, 1900. No. 36267.

Water Waste.

The Use and Waste of Water. Extracts from a report by J. J. R. Croes, analyzing the various sources of use and waste in a large city. 2400 w. Eng Rec—Sept. 1, 1900. No. 36198.

Water Waste and Use in Washington. Extracts from a report by Capt. D. D. Gaillard, describing measurements to determine the waste and the use of water for municipal purposes. 1800 w. Eng Rec—Sept. 22, 1900. No. 36711.

Water-Works.

Lifting Water by Compressed Air. Clark Howell. Illustrates and describes novel features in the adaptation of the air-lift system to pumping water from muddy streams. 2800 w. Met Work—Sept. 15, 1900. No. 36395.

Wells.

Driven Wells (Schlagbrunnen). A discussion of the application of driven wells for local water supply. 1800 w. Gesundheits-Ingenieur—Sept. 15, 1900. No. 36663 B.

MATERIALS.

Asphalt.

The Value of Chemical Tests of Asphalt Mixtures. W. H. Broadhurst. Read before the Am. Soc. of Mun. Imp. On the mistakes in preparing asphalt mixtures which can be detected by chemical analysis. 1500 w. Eng Rec—Sept. 1, 1900. No. 36201.

Cement.

Cement Testing for Municipal Work. Horace Andrews. Read before the Am. Soc. of Munic. Imp. Suggests that cements be tested near their place of manufacture and the packages sealed and marked as to their quality. 1200 w. *Munic Engng*—Sept., 1900. No. 36299 C.

Slag Cement (Ueber Schlacken-Cement). Giving chemical analyses, and numerous results of tests of the Königs-hofer cement. 3000 w. *Stahl und Eisen*—Sept. 1, 1900. No. 36648 D.

The Utilization of Blast-Furnace Slag for Portland Cement Manufacture. Cecil von Schwarz. Abstract of a paper read before the Iron and Steel Institute of Great Britain, describing a method in which the slag is granulated by running it into cold water, then mixed with limestone, etc., pressed and burned. 2200 w. *Eng News*—Sept. 27, 1900. No. 36846.

The Whitehall Portland Cement Works. An illustrated description of the large cement mill at Cementon, Pa., with rotary kilns, and electric driving for the major portion of the plant. 2200 w. *Eng Rec*—Sept. 15, 1900. No. 36416.

Transverse Tests for Cement and Cement Mortar. A statement of the relative advantages of different methods of testing. 1000 w. *Eng Rec*—Sept. 1, 1900. No. 36195.

Concrete Mixer.

A Traveling Concrete Mixer. Illustrates and describes a novel apparatus for the preparation of concrete. 600 w. *Eng News*—Sept. 6, 1900. No. 36318.

Paris Exposition.

The Paris Exhibition. Notes on Materials of Construction. Accounts of a great variety of exhibits of building materials. 3000 w. *Builder*—Sept. 8, 1900. No. 36490 A.

Resistance.

Resistance of Materials (Resistance des Matériaux). A discussion in mathematical and graphical form, of the deformations of beams under various conditions of loading. *Serial*. Part 1. 3000 w. *Revue Technique*—Sept. 10, 1900. No. 36617 D.

Sandstone.

The Relation Between Extension and Stress in Sandstone (Zur Frage der Proportionalität Zwischen Dehnungen und Spannungen bei Sandstein). C. Bach. Investigations into the strength of sandstone, with especial reference to the stresses in revolving grindstones. 2000 w. *Zeitschr d Ver Deutscher Ing*—Sept. 1, 1900. No. 36607 D.

Stresses.

On Wöhler's Laws. J. Gilchrist. Discusses the theory of the cause of fracture, reporting experimental investigations and

giving the writer's conclusions. 5400 w. *Engr. Lond*—Aug. 31, 1900. No. 36359 A.

Suspended Beam.

The Determination of the Stresses in a Horizontal Beam Suspended in the Middle (Zur Bestimmung der Spannungen, in den durch einer Geraden Balken mit Mittelgelenk Versteiften Hängeträgern). J. Melan. A mathematical treatment applicable to the case of a combined suspension and truss bridge. 1500 w. *Zeitschr d Oesterr Ing u Arch Ver*—Sept. 7, 1900. No. 36624 B.

Timber.

Notes on the Swedish Timber Trade. A general account of timber ports and districts, with maps. 1800 w. *Builder*—Sept. 8, 1900. No. 36489 A.

The Creosote-Resinate Wood-Preserving Plant. Illustrated description of works at Perth Amboy, N. J., for the sterilization, vulcanizing, water-proofing and antiseptic treatment of timber. 2300 w. *Eng Rec*—Sept. 22, 1900. No. 36712.

The Preservation of Railway Ties in Europe. O. Chanute. Paper before the Am. Soc. C. E. giving the results of inquiries in Great Britain, France and Germany; with appendices giving specifications in those countries. 7500 w. *Pro Am Soc Civ Eng*—Sept., 1900. No. 36815 E.

MEASUREMENT.**Leveling.**

The Theory and Practice of Precise Spirit Leveling. David A. Molitor. An elaborate paper before the Am. Soc. C. E., with illustrations, tables and curves. 32000 w. *Pro Am Soc Civ Eng*—Sept., 1900. No. 36814 E.

Surveying.

A New Apparatus for Measuring Geodetic Base Lines (Nouveau Dispositif d'Appareils Sewaul à la Mesure des Bases Géodésiques). A. Bergel. Advocating the use of flat iron bars floating in a bath of mercury, for making the measurement. 1000 w. *Comptes Rendus*—Aug. 13, 1900. No. 36638 D.

MUNICIPAL.**Convention.**

The Convention of the American Society of Municipal Improvements. A report of discussions on methods of preparing municipal statistics, cement testing for small cities, and asphalt pavements. 3300 w. *Eng Rec*—Sept. 8, 1900. *Serial*. 1st part. No. 36304.

Mexico.

The Sanitation of Mexico (Assainissement de Mexico). An illustrated description of the new system of sewerage now being installed in the City of Mexico.

1800 w. *Revue Technique*—Sept. 10,
1900. No. 36618 D.

Pavements.

Construction and Maintenance of Brick Pavements. E. A. Kemmler. Read before the Am. Soc. of Munic. Imp. Gives an outline of experience in Columbus, O., and discusses the present standard practice. Ill. 4500 w. *Munic Engng*—Sept., 1900. No. 36296 C.

Construction of Granite Block Pavements. Josiah A. Briggs. Read before the Am. Soc. of Munic. Imp. Describes the standard granite-block pavement in use in city streets, giving the materials used, and details and methods of construction. 3000 w. *Munic Engng*—Sept., 1900. No. 36295 C.

The Construction of Asphalt Pavements. Paper by G. W. Tillson, before Am. Soc. of Munic. Imp., on the foundation, binder, wearing surface, asphaltic cement, sand, and method of laying. 2500 w. *Eng Rec*—Sept. 1, 1900. No. 36199.

The Construction of Standard Medina Block Stone Pavements. E. A. Fisher. Paper presented to the Milwaukee convention of the American Society of Municipal Improvements, giving a detailed description of methods of construction used in Rochester, N. Y. 3000 w. *Eng Rec*—Sept. 15, 1900. No. 36418.

Refuse.

Disposal of Town Refuse. Interesting details from a paper by Brierley Denham Healey, read before the Soc. of Engs., concerning cost and efficiency of various systems. 1600 w. *Engr, Lond*—Aug. 24, 1900. No. 36248 A.

Monograph on the Refuse of Paris (Notice Monographique sur les Ordures Ménagères de Paris). Paul Vincey. A very full account of the system of sorting and removing the garbage and wastes of Paris. Serial. Part I. 10000 w. *Bull Soc d'Encour*—Aug., 1900. No. 36637 G.

The Disposal of House Refuse in Bradford. J. McTaggart. Paper before the British Association, describing the refuse destructors at Bradford, England, where the town refuse is burned, generating steam, and the residual clinker used for various purposes. 4000 w. *Elec Rev, Lond*—Sept. 14, 1900. No. 36737 A.

Sewage Disposal.

Sewage Disposal and Water Purification. John N. McClintock. Read before the Am. Soc. of Munic. Imp. Describes the system of purification by double filtration, or by combining the settling or septic tank with single or double filtration, commending it as certain to give pure water and prevent pollution. 4500 w. *Munic Engng*—Sept., 1900. No. 36298 C.

Sewage Purification. E. A. Hermann. Read before the Am. Soc. of Munic. Imp. A discussion of the various systems. 3400 w. *Munic Engng*—Sept., 1900. No. 36297 C.

The Leeds Sewage Disposal Experiments. From a progress report of the Sewage Committee, describing the different systems tested and giving the results obtained. 1700 w. *Eng Rec*—Sept. 22, 1900. No. 36708.

The Municipal Sewage Works of Berlin (Die Städtischen Kanalisationswerke Berlins). Abstracts from the official report for the fiscal year 1898-99 on the sewer system and filtration beds, giving various statistics. 1600 w. *Gesundh Ing*—July 15, 1900. No. 36560 B.

The Treatment of Leeds Sewage. Abstract of a report of the Leeds Sewage Committee on experiments with various systems. 1200 w. *Engr, Lond*—Sept. 7, 1900. No. 36465 A.

Recently Improved Methods of Sewage Disposal. J. B. Johnson. A paper before the Science Club of the Univ. of Wisconsin, criticising chemical methods and describing the bacterial reduction method. 5500 w. *Bull Univ Wis*—No. 40, June, 1900. No. 36539 D.

Sewers.

Deep Sewer Trenching. Illustrated description of the methods adopted in building a sewer in sand, with its invert 35 to 40 ft. below the street level. 1300 w. *Eng Rec*—Sept. 1, 1900. No. 36196.

Street Cleaning.

Some Actual Working Costs of Motors for Street Watering and Dust Removal. E. Shrapnell Smith. Paper before the Association of Cleansing Superintendents of Great Britain, giving the results of actual experience with steam motors in some English towns. 2000 w. *Autocar*—Sept. 8, 1900. No. 36528 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

Improving the Speed of Submarine Cables. An illustrated description of a method invented by T. Guillaume for lessening the capacity and increasing the

self-induction of cables by the arrangement, shape and material of the conductors. 400 w. *Elec Wild & Engr*—Sept. 15, 1900. No. 36403.

Increase in the Use of Gutta-Percha in Electric Cable Building. Hawthorne Hill. Discusses the demand for new cables and

the supply of gutta-percha. 1800 w. Elec Rev, N. Y.—Sept. 12, 1900. No. 36392.

Sir George S. Robertson's Presidential Address to the Geographical Section of the British Association at Bradford. Abstract of this address, treating of the British Empire and its means of inter-communication by telegraph cable, ships, etc. 3000 w. Electrician—Sept. 14, 1900. No. 36727 A.

Telegraph Cables in War and Two Cables Across the Pacific Ocean (Die Telegraphen Kabel im Kriege und Zwei Kabel durch den Stillen Ocean). A discussion of the question of neutrality of ocean cables in time of war, also a comparison of British and American routes across the Pacific. 5000 w. 1 plate. Stahl und Eisen—Sept. 15, 1900. No. 36651 D.

The Pacific Cable. A criticism of the specifications for the proposed British Pacific cable from Vancouver to Australia and New Zealand. 1100 w. Elec Rev, Lond—Sept. 14, 1900. No. 36736 A.

Cable Steamer.

See Marine Engineering.

Dynamo Currents.

The Use of the Dynamo and Storage Battery in Telegraph Offices. W. J. Camp. Paper before the Canadian Electrical Association, describing different systems in use, with diagrams. 2000 w. Canadian Elec News—Sept., 1900. No. 36508.

Philippines.

Telegraphy in the Philippines. G. D. Rice. An illustrated description of crude methods of Filipino mechanics, and rough-and-ready devices which are used. 1800 w. W Elect'n—Sept. 22, 1900. No. 36747.

Telephone Work and Prospects in the Philippines. The first part tells of the natives' opposition, the system adopted, etc. 1600 w. W Elect'n—Sept. 8, 1900. No. 36347.

Space Telegraphy.

The Slaby-Arco System of Wireless Telegraphy. Illustrates and describes this system, and states the advantages that caused it to be adopted by the German Navy. 800 w. Elec Rev, Lond—Aug. 31, 1900. No. 36368 A.

Synchronograph.

A Practical Telegraph Transmitter Using the Sine-Wave for Operating the Wheatstone Receiver. A. C. Crehore and G. O. Squier. Abstract of a paper before the International Electrical Congress, Paris, giving a description of the synchronograph and accounts of latest practice with it. 600 w. Elect'n, Lond—Sept. 7, 1900. No. 36495 A.

Telegraphone.

Poulsen Telegraphone. An illustrated description of this apparatus for making

a magnetic record of telephone messages on steel wire or ribbon. 1000 w. Sci Am—Sept. 22, 1900. No. 36580.

Telephones.

The Development of Telephony in the German Empire (Entwicklung der Allgemeinen Fernsprechanlagen im Reich-Telephengebiet). A very complete tabulated account of the entire German telephone system, including Bavaria and Württemberg. 12000 w. Elektrotech Zeitschr—Aug. 9, 1900. No. 36676 B.

The New Equipment of the Munich Telephone Central (Die Neuen Münchener Telefon - Centraleinrichtungen). Abstract from the official report of the Bavarian Post and Telegraph Department, describing the new exchange switchboards with incandescent lamp signals. Serial. Part I. 5000 w. Elektrotech Zeitschr—Aug. 23, 1900. No. 36682 B.

Telephone Battery.

Central Battery Telephone System. A description, with diagrams, of a system invented by W. W. Dean, whereby separate batteries at sub-stations may be dispensed with. 1200 w. Elec Wld & Engr—Sept. 15, 1900. No. 36401.

Telephone Circuit.

Telephone Trunk Circuit. A description, with diagram, of an invention by D. S. Hulfish, which provides means to automatically give and remove the busy-test condition to and from the operator's telephone at the switching plug terminal. 1000 w. Elec Wld & Engr—Sept. 15, 1900. No. 36402.

Telephone Signal.

Telephone Jack and Rolling Indicator. An illustrated description of a telephone switchboard signal in which the indicating member is a ball, ring or disk. 800 w. Elec Wld & Engr—Sept. 22, 1900. No. 36719.

Wireless Telephony.

Wireless Telephony. Sir Wm. H. Preece. Paper before the British Association, giving an illustrated description of the author's successful experiments in telephoning across several miles of water, without wires. 1200 w. Elec Engr, Lond—Sept. 14, 1900. No. 36742 A.

DISTRIBUTION.

Aluminum Conductors.

The Use of Aluminum Wire for Electric Transmission Lines. F. A. C. Perrine and F. G. Baum. Abstracted from a paper before the American Institute of Electrical Engineers, giving the practical results attained on a 43-mile three-phase line in California. 2500 w. Eng News—Sept. 27, 1900. No. 36849.

Condensers.

The Employment of Condensers. P.

Boucherot. Paper read at the Paris International Electrical Congress on the application of condensers in commercial alternating current work. 2000 w. *W Elect'n*—Sept. 22, 1900. No. 36748.

Great Britain.

Electric Power Distribution in Great Britain. W. H. Booth. A review of the consequences of the recent decisions of the Parliamentary Commission, showing the difficulties due to municipal intermeddling. 4000 w. *Engineering Magazine*—Oct., 1900. No. 36691 B.

Insulator.

High Voltage Heated Insulator. An illustrated description of A. S. Larsen's method of heating insulators by induced currents, in order to prevent moisture forming. 500 w. *Elec Wld & Engr*—Sept. 22, 1900. No. 36720.

Munich.

An Industrial Object Lesson. An editorial describing a water-power electric plant near Munich, and discussing the industrial and economic effects of this plant and of electric power in general. 1100 w. *Elect'n, Lond*—Sept. 7, 1900. No. 36494 A.

ELECTRO-CHEMISTRY.

Electrolysis.

The Hans A. Frasch Electrolytic Process for Excavating Metals, as Applied to Copper-Nickel Matte. Brief description of the important points in this process, and conclusions from personal investigation. Promises to greatly reduce the cost of producing the useful metals. 2000 w. *Eng & Min Jour*—Sept. 8, 1900. No. 36321.

Electrolyte.

A Galvanic Element with an Electrolyte of Constant Conductivity, Which Can Be Used Both as a Primary and as a Secondary Cell (Ein Primär und Sekundär Benutzbares Galvanisches Element mit Elektrolyten von Unveränderlichen Leitungsvermögen). Ernst W. Jungner. It is proposed to use a solution of an alkali hydrate, and it is claimed that neither its concentration nor its composition will alter. 1200 w. *Elektrochem Zeitschr*—Aug., 1900. No. 36561 G.

Electricity Cell.

Feeding Arrangement for Electrolytic Apparatus (Speisevorrichtung für Elektrolytische Zersetzungs-apparate). Raul Girouard. Illustrated description of an apparatus in which liquid is transferred from a reservoir to an electrolytic cell automatically, without the two bodies of liquid coming in contact with each other. 900 w. *Elektrochem Zeitschr*—Aug., 1900. No. 36562 G.

Ionization.

The Transfer of Hydrogen Ions as Determined by Measurements with Lead Ac-

cumulators (Die Ueberführungszahl von Schwefelsäuregemischen aus Messungen am Blei-Akkumulator). Arthur Kendrick. Account of research work, in which the electromotive-force of the lead accumulator was exactly determined, and also the migration of hydrogen ions. 3000 w. *Zeitschr f Elektrochem*—Aug. 2, 1900. No. 36564 D.

Paris Exposition.

Electro-Chemistry and its Allied Interests at the Paris Exposition of 1900 (Die Elektrochemie und ihre Weitere Interessensphäre auf der Pariser Weltausstellung 1900). Prof. W. Borchers. A general review of electrochemical, mineralogical and other exhibits. Serial. 1st part. *Zeitschr f Elektrochem*—July 26, 1900. No. 36563 D.

Polarization.

On the Production of Asymmetrical Alternating Currents by Means of Electrolytic Polarization. W. L. Hildburgh. Doctorate thesis on electrolytic methods of rectifying alternating currents, with curves and tables. 1 plate. 6500 w. *School of Mines Quar*—July, 1900. No. 36540 D.

Print Works.

Electro-Chemistry in a Dye and Print Works. A. E. Sunderland. Read at Bradford, Eng., Technical College. Reviews the applications of electricity in works of this character, the action of the electric current on dye-ware, giving some of the results, etc. 2000 w. *Elect'n, Lond*—Aug. 31, 1900. No. 36367 A.

Zinc.

The Electrolytic Production of Zinc with the Employment of Insoluble Anodes, Combined with the Profitable Use of the Material of the Anodes (Elektrolytische Zinkgewinnung unter Anwendung Unlöslicher Anoden. Verbunden mit Gleichzeitiger Verwertung des Anodenmaterials). J. Routschewsky. An illustrated description of a process in which the electrolyte is an acid zinc sulphate solution and the anode is of lead. Serial. 2 parts. 4500 w. *Zeitschr f Elektrochemie*—July 12, 19, 1900. No. 36556 each D.

ELECTRO-PHYSICS.

Dust Figures.

Dust Figures of Electrostatic Lines of Force. David Robertson. An illustrated account of apparatus used and figures obtained. 1600 w. *Elec Rev, Lond*—Sept. 7, 1900. No. 36499 A.

Electric Force.

Some Remarks Upon the Cause and Nature of the Electric Force. R. C. Shettle. Facts and arguments in support of the hypothesis that matter was formed by cohesion, and that the part which did not undergo condensation constitutes the

ether, and is the basis of the electric force. 3500 w. *Elec Engr*, Lond—Aug. 24, 1900. No. 36229 A.

Electric Quantities.

On the Nature of the Electric and Magnetic Quantities. Reginald A. Fessenden. Letter, in reply to a criticism, on the writer's system of "Qualitative Mathematics," and explanation of natural phenomena. 1000 w. *Elec Rev*, Lond—Sept. 14, 1900. No. 36738 A.

Electrical Stimulus.

On the Similarity of Effect of Electrical Stimulus on Inorganic and Living Substances. Prof. J. Chunder Bose. A paper before the British Association, on molecular change produced by electric stimulus. Also editorial. Serial. 1st part. 5000 w. *Electrician*—Sept. 14, 1900. No. 36724 A.

Electromagnetism.

Electromagnetic Mechanisms. Silvanus P. Thompson. A paper before the International Electrical Congress, at Paris, giving electromagnetic principles and their applications, with the principal classes of electromagnetic mechanisms. 1800 w. *Elec Rev*, N. Y.—Sept. 19, 1900. No. 36731.

Electromagnets.

The Design of Tractive Electromagnets. Lamar Lyndon. A mathematical letter, with diagram, showing how the travel of a plunger may be lengthened by shaping the pole faces conically. 800 w. *Elec Wld & Engr*—Sept. 15, 1900. No. 36404.

Hydro-Electricity.

The Production and Utilization of Electricity from Steam (*De la Production et de l'Utilisation de l'Electricité Tirée de la Vapeur d'Eau*). E. E. Stahl. Showing the conditions under which a current may be developed from a steam jet. Possible applications are given. Serial. Part I. *Revue Technique*—Aug. 10, 1900. No. 36613 D.

Interrupter.

Liquid Interrupters Connected in Parallel (*Die Neuen Flüssigkeitsunterbrecher in Parallelschaltung*). E. Ruhmer. Giving the results of experiments with Wehnelt interrupters. 2000 w. *Elektrotech Zeitschr*—Aug. 16, 1900. No. 36678 B.

Lines of Force.

The Distribution of Lines of Force in a Dynamo (*Die Gesetze der Kraftlinienvertheilung über den Umfang der Dynamomaschinen*). Ch. Westphal. An analytical investigation of the laws governing the distribution of magnetic force, with diagrams for practical use. 3500 w. *Elektrotech Zeitschr*—Sept. 6, 1900. No. 36685 B.

Wave Forms.

Conditions Affecting the Wave Form of

Alternators. L. A. Herdt and E. M. Archibald. Paper before the Canadian Electrical Association, discussing forms of electromotive-force waves under commercial conditions, with diagrams. 800 w. *W Elect'n*—Sept. 15, 1900. No. 36505.

GENERATING STATIONS.

Alternating-Currents.

Periodicity in Alternating Current Apparatus. James M. Andrews. Read before the Ohio Elec. Lgt. Assn. Discusses separately each periodicity, its value as regards transformers, line losses, induction motors, etc., and the different systems. 3500 w. *W Elect'n*—Sept. 8, 1900. No. 36348.

Apparatus.

Hints on the Care of Generators and Motors. John H. Hertner. An illustrated article giving practical points. 1500 w. *Engr*, U. S. A.—Sept. 15, 1900. No. 36488.

Combined Plant.

Electric, Gas and Heating Plants. Alton D. Adams. An article calling attention to the possibilities of saving by combination of electrical supply stations and gas works. 2000 w. *Elec Rev*, N. Y.—Sept. 19, 1900. No. 36728.

The Operation of a Combined Lighting and Power Plant. J. H. Perkins. Read before the Ohio Elec. Lgt. Assn. An account of practice at Youngstown, O. 3300 w. *W Elect'n*—Sept. 1, 1900. No. 36350.

Consolidation.

Commercial Analysis of Small and Unprofitable Electric Lighting and Power Enterprises. William D. Marks. Analytical study of the factors in enterprises dealing with small amounts. 3000 w. *Elec Wld & Engr*—Sept. 1, 1900. No. 36217.

Costs.

Lightning's Table of Costs. An analysis of the accounts of electricity supply undertakings established under provisional orders in the United Kingdom. Tables of statistics of public and private corporations. 4000 w. *Lightning*—Sept. 6, 1900. No. 36504 A.

Design.

Foreign and English Electrical Engineering. Part first considers slow-speed steam dynamos. These articles will discuss the general growth and position of the electrical industry, the differences of practice and conditions, and related subjects. 3400 w. *Engr*, Lond—Aug. 24, 1900. Serial. 1st part. No. 36244 A.

Dynamos.

The Construction of Large Dynamos as Exemplified at the Paris Exhibition. Silvanus P. Thompson. Abstract of paper

before the British Association, giving a review of the dynamos at the Exhibition and calling attention to the tendencies in design which they illustrate. 1600 w. Elec Engr, Lond—Sept. 14, 1900. No. 36740 A.

Dynamotors.

Dynamotors versus Motor Generators. Alton D. Adams. A comparison showing the former to be superior in many ways, but that the other machine was brought into favor because of the difficulty in regulating the secondary pressure in the dynamotor. 1800 w. Elec Wld & Engr—Sept. 8, 1900. No. 36327.

Earnings.

How Can Central Stations Earn Larger Revenues? Albert B. Herrick. A discussion of the possible resources for increasing the revenue. 2000 w. Elec Wld & Engr—Sept. 1, 1900. Serial. 1st part. No. 36214.

Economy.

The Future of Electrical Power. Summary of a popular lecture by Prof. S. P. Thompson, advocating the substitution of large steam engines for small ones, and the establishment of large central stations using coal fuel. 700 w. Ir & Coal Trds Rev—Sept. 14, 1900. No. 36776 A.

Exposition.

Electricity at the Paris Exposition (Die Elektrizität auf der Pariser Weltausstellung). Désiré Korda. The first installment of an extended report. This article discusses the polyphase generators exhibited. Serial, Part I. 2000 w. Elektrotech Zeitschr—Aug. 23, 1900. No. 36679 B.

Some Swiss Exhibits at Paris. Frank C. Perkins. A short illustrated account of some polyphase generators. 500 w. W Elect'n—Sept. 15, 1900. No. 36506.

Generating Set.

Electrical Generating Set of 1,000 Horse Power (Groupe Electrogène de 1,000 Chevaux). Ch. Parcey. A description of the horizontal Corliss engine of Escher, Wyss & Co., of 1,000 h.p., and the Oerlikon electrical generator of 1,300 kilowatts at the Paris Exposition. 1000 w. Génie Civil—Sept. 1, 1900. No. 36634 D.

Generators.

Single and Polyphase Alternate Current Generators. Discusses the principles upon which these machines are constructed, and gives an illustrated description explaining their operation. Col Guard—Aug. 24, 1900. Serial. 1st part. No. 36234 A.

Glasgow.

The Electricity Supply of Glasgow. An illustrated general description of the new Port Dundas electricity works for light-

ing Glasgow. 3000 w. Engr. Lond—Sept. 14, 1900. No. 36702 A.

The New Electricity Works of the Glasgow Corporation. An historical review of the enterprise and an illustrated description of the new works. Serial. 1st part. 2200 w. Electrician—Sept. 14, 1900. No. 36722 A.

High Pressure.

Modern High-Pressure Apparatus (Ueber Moderne Hochspannungsapparate). H. A. Bertram. Describing improved arrangements of switches, switchboards, transformers, insulators, etc., for high-pressure currents. Two articles, 7000 w. Elektrotech Zeitschr—Aug. 9, 16, 1900. No. 36674 each B.

Hospital Plant.

The New Power Plant of the Massachusetts General Hospital. Illustrated description of a plant designed to furnish electric current, steam heat and hot water to a group of buildings. 1800 w. Eng Rec—Sept. 1, 1900. No. 36204.

Isolated Plants.

The Steam-Driven Isolated Plant—Does It Pay? W. D. Ennis. Comparisons of the cost with isolated plants and the cost of buying current from central stations. 3000 w. Elec Wld & Engr—Sept. 22, 1900. No. 36715.

Lachine.

The Electric Light and Power Plant of the Lachine Rapids Hydraulic & Land Company. Charles T. Child. Illustrated description of a twelve-thousand horsepower hydraulic and electric station that lights Montreal and furnishes power to its industries. 3500 w. Elec Rev, N. Y.—Sept. 12, 1900. No. 36391.

Load Factors.

Load Factors on Traction Stations. William H. Booth. States the conditions of working in the power house of an electric tramway, and the means of determining the load factor. 2000 w. Elec Rev, Lond—Aug. 31, 1900. No. 36370 A.

Motor-Generator.

Some Experiments with a Motor-Generator. An account of tests made to ascertain why the machine failed to do the work for which it was designed. Ill. 1600 w. Am Elect'n—Sept., 1900. No. 36269.

Rathmines.

Rathmines Municipal Electricity Works. An illustrated description of a small but very complete plant near Dublin. 2000 w. Engr, Lond—Sept. 7, 1900. No. 36468 A.

Rotary Converters.

Some Experiments with Rotary Converters. A. G. Grier and J. C. Hyde.

Paper before the Canadian Electrical Association, with diagrams and curves. 1500 w. Canadian Elec News—Sept., 1900. No. 36511.

South London.

The City and South London Railway. A well illustrated account of the new generating station of this underground road. 2400 w. Elec Rev, Lond—Sept. 7, 1900. No. 36500 A.

Station Design.

Some General Conditions Governing Power Station Design. Philip Dawson. From a paper before the Light Railway and Tramway Conference, London, with tables. 2000 w. St Ry Rev—Sept. 15, 1900. No. 36517 C.

Variable Load.

See Mechanical Engineering, Steam Engineering.

LIGHTING.

Address.

The Association of Edison Illuminating Companies; Its Field and Work—Past, Present and Future. John W. Lieb, Jr. Presidential address before the Saratoga Springs Convention, Sept., 1900. 2000 w. Elec Rev, N. Y.—Sept. 12, 1900. No. 36393.

Arc.

Progress in Arc Lighting by Alternating-Current Lamps. H. W. Hillman. Read before the Ohio Elec. Lgt. Assn. Discusses the subject in its relation to street lighting principally. 2500 w. W Elect'n—Sept. 1, 1900. No. 36349.

The Production of an Artificial Light of the Same Character as Daylight. A. Dufton and W. M. Gardner. Abstract of paper before British Association, discussing the subject generally, and describing a means of modifying the electric arc's light by passing it through pale blue glass. 800 w. Electrician—Sept. 14, 1900. No. 36725 A.

Auditorium Lighting.

The Lighting of the Coliseum. Illustrates and describes the arrangements for lighting an auditorium said to have a capacity of 10,000. 1700 w. W Elect'n—Sept. 8, 1900. No. 36346.

Convention.

The Field and Work of the Association of Edison Illuminating Companies. J. W. Lieb, Jr. Presidential address at the Saratoga convention of the Association. 2100 w. W Elect'n—Sept. 22, 1900. No. 36749.

The Twenty-first Edison Convention. An outline of the proceedings of this convention, with a general review of some of the work of past conventions. 4000 w. Elec Wld & Engr—Sept. 15, 1900. No. 36400.

Decorative Illumination.

Special Lighting Effects at the Paris Exposition. Brief illustrated description of some of the striking night effects. 1000 w. Elec Wld & Engr—Sept. 8, 1900. No. 36326.

The Decorative Illumination of Electricity Building, Paris Exposition. Illustrated detailed description. 2500 w. Elec Wld & Engr—Sept. 1, 1900. No. 36215.

Fountains.

The Electric Fountains at the Paris Exposition. A well illustrated description of the Chateau d'Eau and the electric fountains. 2500 w. Elec Wld & Engr—Sept. 22, 1900. No. 36714.

Incandescent.

A New Incandescent Street Lamp Fixture. A. B. Proal. Reviews the systems used in incandescent street lighting, and gives illustrated description of a new shunting device. 1200 w. Elec Wld & Engr—Sept. 1, 1900. No. 36218.

High Voltage Incandescent Lamps. George D. Shepardson. A discussion of the present situation and the conclusion that these lamps are a commercial success and coming into extensive use. 3600 w. Elec Wld & Engr—Sept. 1, 1900. No. 36216.

Nernst Lamp.

The Nernst Lamp in Commercial Form at the Paris Exposition. C. L. Durand. An illustrated description of present forms of the Nernst lamp. 2500 w. Elec Rev, N. Y.—Sept. 19, 1900. No. 36729.

Oxides.

The Conductivity of Oxides at High Temperatures (Ueber die Leitungsfähigkeit der Oxyde bei Hohen Temperaturen). J. Sohlman. An examination of a large number of oxides with a view of determining their conductivity and use for incandescent lighting. 1800 w. Elektrotech Zeitschr—Aug. 19, 1900. No. 36675 B.

MEASUREMENT.

Alternating Current.

Measurement of Alternating Currents by Current and Pressure Meters (Methode zur Bestimmung des Effektes in Wechselstromkreise mittels Strom- und Spannungsmesser). E. Reisz. An improvement on the ordinary method, requiring only two measuring instruments. 1200 w. Elektrotech Zeitschr—Aug. 23, 1900. No. 36681 B.

Meter.

A Combination Integrating Wattmeter and Maximum-Demand Indicator. J. H. Barker. Paper read before the British Association, discussing maximum demand and describing a combined meter

and indicator. 1800 w. Elec Eng, Lond—Sept. 7, 1900. No. 36502 A.

Switchboard Instruments—Integrating Wattmeters and Ammeters. Wm. Baxter, Jr. An illustrated description of some electrical measuring instruments. 2700 w. Am Mach—Sept. 27, 1900. No. 36818.

The Holden Electric Meter (Compteur d'Energie Electrique, Systeme Holden). J. A. Montpellier. A motor meter operating on the principle of discontinuous integration. The details of construction and operation are fully described. 2000 w. Electricien—Aug. 11, 1900. No. 36686 B.

Moment of Inertia.

On Some Methods of Determining Experimentally the Moments of Inertia of the Rotors of Dynamos and Alternators. Alfred Hay. Part first states two problems in which the moment of inertia is of importance, and commences the discussion of methods by means of which this quantity may be experimentally determined. 1400 w. Elec Rev, Lond—Aug. 24, 1900. Serial. 1st part. No. 36231 A.

Polyphase Systems.

A Graphical Method of Determining the Current and Pressure in Connected Polyphase Systems (Eine Graphische Methode zur Bestimmung der Strom- und Spannungswerthe in Verketteten Mehrphasensystemen). F. Blanc. Giving the derivation of graphical diagrams, with examples of their practical application. Two articles, 5000 w. Elektrotech Zeitschr—Aug. 30, Sept. 6, 1900. No. 36684 each B.

Rating.

The Necessity for a Normal Rating of Capacity, Temperature and Efficiency of Electrical Machines (Ueber die Nothwendigkeit der Aufstellung von Normen für die Bestimmung und Angabe von Leistung, Erwärmung und Wirkungsgrad Elektrischer Maschinen). G. Dettmar. A paper before the German Electrical Engineers urging the adoption of standards. 10000 w. Elektrotech Zeitschr—Aug. 30, 1900. No. 36683 B.

Testing.

A Running Test on Street Car Motors. E. C. Parham. Discusses the causes that help to make the drops across the two motors to differ. 1400 w. Am Elect'n—Sept., 1900. No. 36271.

The Electric Testing Train on the Wannsee Road, near Berlin (Der Elektrische Versuchsbetrieb auf der Wanneseebahn bei, Berlin). R. Rinkel. A full account of comparative trials between steam and electric driving, with description of the apparatus and results. 5000 w. Zeitschr d Ver Deutscher Ing—Sept. 8, 1900. No. 36611 D.

POWER APPLICATIONS.

Canal Haulage.

Electric Traction for Canals. Report by Consul-General Richard Guenther, Frankfort, on experiments made on behalf of the Prussian Government by Siemens & Halske on a short length of the Finow Canal, between Berlin and Stettin. 600 w. U. S. Consular Reports—Sept. 20, 1900. No. 36544.

Cranes.

Electrical Travelling Cranes. C. W. Hill. A general review, with a short illustrated description of a multiple-motor crane. 1200 w. Elec Rev, Lond—Sept. 7, 1900. No. 36497 A.

Electric Traveling Crane with Moveable Frame (Grue Electrique à Charpente Mobile). An illustrated account of the travelling wharf crane on the Quai d'Orsay at the Paris Exposition. 1500 w. Revue Technique—Aug. 25, 1900. No. 36614 D.

Diagrams.

Diagrams for Induction Motors (Diagramme für Induktionsmotoren). R. Goldschmidt. Deriving diagrams for showing the performances for various kinds of induction motors. 4500 w. Elektrotech Zeitschr—Aug. 16, 1900. No. 36677 B.

Domestic.

Unutilized Comforts of Electricity. R. S. Hale. A general description of various devices, which can be easily applied and do not add much to cost of wiring a house. 1000 w. Elec Wld & Engr—Sept. 22, 1900. No. 36716.

Electric Driving.

Electrical Power Transmission in Smelting Works. A well illustrated description of a plant for generating electricity for power purposes in a large smelting works. 3200 w. Elec Rev, Lond—Sept. 14, 1900. No. 36739 A.

On the Subdivision of the Motor Equipment in Electrically-Driven Workshops. Short discussion of the subject, with some examples of European practice. 1200 w. Elect'y, Lond—Sept. 7, 1900. No. 36501.

The Commercial Value of Independent Electric Driving (Elektrischer Einzelantrieb und seine Wirtschaftlichkeit). O. Lasche. Showing the great advantages in handling materials and conducting work by use of electric driving. 2000 w. Stahl und Eisen. Sept. 15, 1900. No. 36652 D.

The Electric Driving of Ironworks and Rolling Mills. O. Lasche. Abstract from *Technisches Centralblatt*. An illustrated account of the driving at the rolling mills of the Oberspreew cable works, and a discussion of the advantages as

compared with steam driving. 2200 w. *Elect'n*, Lond—Aug. 31, 1900. No. 36-366 A.

The Value of Independent Electric Driving (*Elektrischer Einzelantrieb und seine Wirtschaftlichkeit*). O. Lasche. Showing especially the great advantages in the clearing of belts, etc., from workshops by the use of electric driving. Serial, Part I. 4000 w. *Zeitschr d Ver Deutscher Ing*—Sept. 8, 1900. No. 36-610 D.

Wellington Foundry, Lincoln. A general description of the large machine and engine works of William Foster & Co., which are equipped for the electric driving of the machinery. 2400 w. *Engr*, Lond—Sept. 7, 1900. No. 36467 A.

Induction Motors.

Alternating-Current Induction Motors. A. C. Eborall. The full report of the discussion on the above paper, reprinted from the journal of the Institution of Electrical Engineers. 7000 w. *Elect'n*, Lond—Sept. 7, 1900. No. 36496 A.

Lift.

An Electric Stair Lift. A well illustrated description of the Dodge link-belt stair lift, in which the treads are horizontal. 700 w. *Elec Wld & Engr*—Sept. 22, 1900. No. 36721.

Electric Inclined Elevators for the Elevated Railway. A short illustrated description of the Reno inclined elevator at the Manhattan Elevated Railroad Station at Third avenue and Fifty-ninth street. 400 w. *Elec Wld & Engr*—Sept. 15, 1900. No. 36399.

Motor.

Design for a Three Horse-Power Motor. Cecil P. Poole. Illustrates and describes a design prepared with a view to simplifying the work without sacrificing the efficiency, or making the machine unduly heavy. 1500 w. *Am Elect'n*—Sept., 1900. No. 36270.

See Mechanical Engineering, Automobilm.

Polyphase.

Theory of Asynchronous Polyphase Motors (*Theorie der Asynchronen Mehrphasen motoren*). G. Ossanna. A graphical derivation of the theory of the polyphase motor. 2500 w. *Elektrotech Zeitschr*—Aug. 23, 1900. No. 36680 B.

Power Factor.

Power Factor as Affecting Operation and Investment, with Special Reference to Induction Motors and Enclosed Arc Lamps. F. H. Leonard, Jr. Paper before the Canadian Electrical Association, giving a general discussion of the subject. 2800 w. *Canadian Elec News*—Sept., 1900. No. 36510.

Starting Switch.

An Automatic Switch for Starting Electric Motors. An illustrated description of an automatic switch invented by Walter F. Jones, to prevent an undue rush of current at starting motors. 2000 w. *Col Guard*—Sept. 14, 1900. No. 36-763 A.

TRANSMISSION.

Regulation.

Regulation in Long-Distance Power Transmission by Electricity. Frederic A. C. Perrine. Abstracted from a paper read before the Pacific Coast Elec. Trans. Assn. Calls attention to points demanding careful consideration. 2200 w. *Eng News*—Sept. 6, 1900. No. 36317.

Tesla Patents.

The Tesla Patents. Decision of Judge Townsend of the United States Circuit Court of Connecticut in favor of the Tesla patents for the polyphase transmission of power in the suit of the Westinghouse Elec. & Mfg. Co., against the New England Granite Co. 6000 w. *Elec Rev*, N. Y.—Sept. 19, 1900. No. 36733.

MISCELLANY.

Austro-Hungary.

The Condition of Heavy Electrical Engineering in Austro-Hungary (*Die Lage der Starkstromindustrie in Oesterreich-Ungarn*). A general review of the electrical engineering situation, taken from the Vienna *Electro-Techniker*. 1900 w. *Zeitschr f Klein-u Strassenbahnen*—Aug. 1, 1900. No. 36553 C.

Congress.

International Electrical Congress. An account of the proceedings of the International Electrical Congress at Paris, with abstracts of the principal papers presented. 6000 w. *Elec Wld & Engr*—Sept. 15, 1900. No. 36398.

The International Electrical Congress. Short abstracts of various papers presented. 2100 w. *Elec Wld & Engr*—Sept. 22, 1900. No. 36717.

Exposition.

Electricity at the Pan-American Exposition. A description and floor plan of the Electricity Building. 1500 w. *W Elect'n*—Sept. 22, 1900. No. 36746.

The Palace of Electricity at the Exposition of 1900 (*Exposition de 1900. Palais de l'Electricité*). R. Weil. Giving details of the framework of the construction of this important building of the exposition, and interior and exterior views, including the Chateau d'Eau, or illuminated electric fountain. 3000 w. 1 plate. *Génie Civil*—Sept. 1, 1900. No. 36633 D.

GAS ENGINEERING

Acetylene.

Acetylene for Railroad Lighting. An illustrated description of the Bournonville Generator. 500 w. R R Gaz—Sept. 28, 1900. No. 36807.

Acetylene for Train Lighting. A. Lipschultz. From a paper before the Civil Engineers' Society of St. Paul, Minn., on "The Use of Acetylene in Railway Station and Train Lighting." 3000 w. Am Gas Lgt Jour—Sept. 17, 1900. No. 36473.

Alkali Works.

The Alkali Works Report. Harold G. Colman. On the parts of the report of interest to gas manufacturers, and also an extract on the desulphurizing of gas liquor. 4000 w. Gas Wld—Sept. 1, 1900. No. 36365 A.

Ammoniacal Liquor.

The Report of the Chief Inspector Under the Alkali Act. The Constitution and Analysis of Ammoniacal Liquor. From the report of R. Forbes Carpenter, giving the results of examinations of the constitution of various ammoniacal liquors from English and Scotch sources. 4000 w. Jour Gas Lgt—Sept. 11, 1900. No. 36798 A.

Calorific Power.

The Heating and Lighting Power of Coal Gas. T. Fairley. Paper read before the British Association, showing the relation between the heating and lighting powers of coal gas. 900 w. Jour Gas Lgt—Sept. 18, 1900. No. 36828 A.

Congress.

The International Gas Congress. An account of the proceedings of the Gas Congress at Paris, with abstracts of the papers read. 13000 w. Gas Wld—Sept. 8, 1900. No. 36474 A.

The International Gas Congress in Paris. A review of the proceedings and a résumé of the papers read. 20000 w. Jour Gas Lgt—Sept. 11, 1900. No. 36795 A.

The International Gas Congress. Opening address of the president, M. Theodore Vautier. A general review of gas engineering. 7000 w. Jour Gas Lgt—Sept. 18, 1900. No. 36821 A.

Cyanides.

The Production and Manufacture of Cyanides in Gas-Works. Dr. Bueb. A paper before the International Gas Congress, Paris, giving a process of extracting cyanogen from illuminating gas by contact with a solution of an iron salt. 2000 w. Jour Gas Lgt—Sept. 18, 1900. No. 36823 A.

Dellwik Process.

The Dellwik Process. Wm. Young. From a paper before the North British Association of Gas Managers, giving an account of a process in which intense local heating is produced by an air blast. 1000 w. Pro Age—Sept. 15, 1900. No. 36472.

Distribution Losses.

How to Diminish Distribution Losses. P. H. Gibbons. A paper before the "Congrès International de l'Industrie du Gaz en 1900," at Paris, containing a general discussion of causes of losses and means of prevention. 3000 w. Pro Age—Sept. 15, 1900. No. 36471.

Education.

Educational Work of a Gas Association. Alfred E. Forstall. A paper before the "Congrès International de l'Industrie du Gaz en 1900," at Paris, giving an account of the work of the American Gas Light Association in educating men and boys employed in gas-works. 2700 w. Pro Age—Sept. 15, 1900. No. 36470.

Foul Gases.

Treatment of Foul Gases from Sulphate Plants. An account of interesting experiments extracted from the annual report of the Chief Inspector under the Alkali Acts, in England. 3400 w. Gas Wld—Aug. 25, 1900. No. 36298 A.

High Pressure.

The Reduction of the Cost of Distribution by the Use of High Pressures. Fred. H. Shelton. Paper before the Paris Gas Congress, advocating the use of high pressure and showing its advantages; with illustrations. 5000 w. Gas Wld—Sept. 15, 1900. No. 36793 A.

Hydrocyanic Acid.

The Absorption of Hydrocyanic Acid from Illuminating Gas. Dr. A. Smits. Paper communicated to the International Gas Congress, Paris, on the production of yellow prussiate (ferrocyanide) of potash by the wet process. 900 w. Jour Gas Lgt—Sept. 18, 1900. No. 36824 A.

Inclined Retorts.

Inclined Retorts. C. E. Brackenbury. A paper before the International Gas Congress at Paris, giving an illustrated account of up-to-date English practice with inclined retorts for carbonizing coal. 2800 w. Gas Wld—Sept. 8, 1900. No. 36476 A.

Mains.

Laying a 24-inch Gas Main Across the Harlem River. G. H. P. McVey. An illustrated description of work undertaken by the Consolidated Gas Co., to connect

Manhattan and the Bronx, New York. 1200 w. *Sci Am*—Sept. 15, 1900. No. 36386.

Submerged Gas Mains. An illustrated account of work done to connect the district beyond the Harlem River, known as the Bronx, with the mains of the Consolidated Gas Co., of New York. 1000 w. *Pro Age*—Sept. 1, 1900. No. 36209.

Meters.

Slot Consumption Where Meters and Fittings, etc., are Supplied. George Helps. An opinion on paying averages, and one way of obtaining them. 2500 w. *Jour Gas Lgt*—Aug. 28, 1900. No. 36251 A.

Naphthalene.

A Method of Preventing Naphthalene Obstructions. Dr. Bueb. A paper before the International Gas Congress, Paris, giving a process of abstracting naphthalene from gas by bringing the latter, as it leaves the tar extractor, into intimate contact with a tar oil of very high boiling point. 1000 w. *Jour Gas Lgt*—Sept. 18, 1900. No. 36822 A.

Natural Gas.

Natural Gas. Its Production and Consumption. Abstract of a U. S. Geological Survey report compiled by F. H. Oliphant, comprising a survey of the gas fields, a discussion of the question of their exhaustion, and statistics concerning the utilization of natural gas in iron and steel industries. 2000 w. *Ir Age*—Sept. 27, 1900. No. 36756.

Paris.

The Visit to the Clichy Works of the Paris Gas Company. A description, with plan of these large and complete works, which were visited by the delegates to the International Gas Congress. 1000 w. *Jour Gas Lgt*—Sept. 11, 1900. No. 36796 A.

Paris Exhibition.

The Gas Industry of the Exposition of 1900. J. Leroy, in *La Nature*. Illustrated account of the work done by the Compagnie Parisienne du Gas and the applications within the Exposition enclosure. 2000 w. *Sci Am Sup*—Sept. 15, 1900. No. 36388.

Power Gas.

The Blast Furnace as a Power Producer. A short illustrated account of the Thwaite-Gardner system of using blast-

furnace gases in gas engines. 1000 w. *Ir & Steel Trds Jour*—Sept. 15, 1900. No. 36781 A.

Pyrometer.

The Measurement of High Temperatures. Alten S. Miller. Paper before the Paris Gas Congress, describing the Uehling-Steinbart pneumatic pyrometer, and advocating its use in gas works. 1100 w. *Gas Wld*—Sept. 15, 1900. No. 36794 A.

Retort House.

Waverley Association of Gas Managers. Half-yearly meeting at Dalkeith. The address of the president, W. McGiffen, on the practical working of the retort house, and the ensuing discussion. 4000 w. *Jour Gas Lgt*—Sept. 18, 1900. No. 36827 A.

Stoves.

Gas Stoves (Die Gasheizöfen). E. Nicolaus. Reviewing the development of the gas stove for warming rooms, and discussing the conditions necessary for healthfulness. Serial, Part I. 3000 w. *Gesundheits-Ingenieur*—Aug. 31, 1900. No. 36662 B.

Water Gas.

Carburetted Water Gas and Its Use in Coal-Gas Works. Henri Sospicio. An illustrated paper before the International Gas Congress, Paris, giving methods of water-gas manufacture; with discussion by A. G. Glasgow. 6000 w. *Jour Gas Lgt*—Sept. 18, 1900. No. 36825 A.

Water Gas as a Remedy for the Prevalent Scarcity of Coal. H. Dicke. Presenting the advantages due to the Dellwik-Fleischer process. 2000 w. *Jour Gas Lgt*—Aug. 28, 1900. No. 36250 A.

Welsbach.

Incandescent Gas Lighting. Dr. H. Bunte. A paper before the International Gas Congress, at Paris, showing the change the Welsbach light has made in the kind of gas produced, and giving results of photometric tests of Welsbach mantles. 3000 w. *Jour Gas Lgt*—Sept. 22, 1900. No. 36797 A.

Wood Gas.

Generating Gas from Wood. James M. Neil. Explains the principle of the gas generator invented by H. Riché, of Paris, and gives illustrated description. 900 w. *Eng & Min Jour*—Sept. 8, 1900. No. 36325.

MARINE AND NAVAL ENGINEERING

Cable-Steamer.

Germany's First Cable-Laying Steamer. Illustrated detailed description of the "Von Podbielski." 2200 w. *Sci Am Sup*—Sept. 8, 1900. No. 36314.

Colliers.

Twenty Years' Progress in Coal-Carrying Steamers. J. F. Walliker. Abstract of a paper before the Institute of Marine Engineers, reviewing the progress made

in boilers and engines. 2200 w. *Ir & Coal Trds Rev*—Sept. 7, 1900. No. 36-485 A.

Cruiser.

The Imperial Russian Cruiser "Bayan." Illustrates and describes the armoring system, equipment and novel features. 1200 w. *Engr, Lond*—Aug. 31, 1900. No. 36-362 A.

Floating Dock.

The Floating Dock as an Adjunct to a War Navy. Lyonel Clark. Read before the International Congress, at Paris. Discusses the size and construction; the advantages, limitations and cost, making comparison with the graving dock. Ill. 7000 w. *Engs' Gaz*—Sept., 1900. No. 36364 A.

Japan.

The Nippon Yusen Kaisha. A report concerning the successful operations of the Japan Steamship Co. 1100 w. *Engng*—Aug. 24, 1900. No. 36240 A.

Light-Ship.

Diamond Shoal Light-Ship. A short description of the staunchest and most thoroughly equipped vessel of her class in the world, to be placed off Cape Hatteras. 600 w. *Marine Rev*—Sept. 13, 1900. No. 36436.

Marine Engines.

Materials Used in the Construction of Marine Dynamos and Their Engines. Alton D. Adams. Discusses the best material to use in the different parts. 2500 w. *Marine Engng*—Sept., 1900. No. 36-259 C.

Marine Railway.

Great Marine Railway. Splendid New Crandall-designed dry-dock at the Townsend & Downey shipyard, in New York harbor. A description, with illustration, of marine railway and shipyard on Shooter's Island, Newark Bay. 900 w. *Naut Gaz*—Sept. 20, 1900. No. 36861.

Navigation.

Navigation Interests of Nations. Lyndon W. Bates. Read before International Cong., at Paris. On the value of navigation in advancing international trade and the sense in which it is a national matter, and the duty of the government in regard to public works. 2800 w. *Marine Rev*—Aug. 30, 1900. No. 36206.

Ocean Records.

The Atlantic Record. Comment on the records of the "Kaiser Wilhelm der Grosse," of the North German Lloyd Co., and the "Deutschland," of the Hamburg-American line, as compared with English vessels. 1700 w. *Engr, Lond*—Aug. 24, 1900. No. 36246 A.

Oregon.

The Damage to the "Oregon." A de-

scription of the damage caused by grounding on a submerged rock in Chinese waters, illustrated from photographs. 600 w. *Sci Am*—Sept. 29, 1900. No. 36809.

Propulsion.

Modern Steamship Propulsion. W. H. Atherton and A. L. Mellanby. A mathematical discussion of the speed of ships, with diagrams. 1800 w. *Pract Eng*—Sept. 7, 1900. No. 36450 A.

On the Mechanical Theory of Steamship Propulsion. Robert Mansel. A mathematical discussion. 2500 w. *Engr, Lond*—Aug. 24, 1900. No. 36243 A.

Reconstruction.

Interesting Ship Repair Work. An account of the lengthening of the hull and the reconstruction of the stern of an Italian passenger and cargo vessel, by the Wallsend Slipway and Engineering Co. 800 w. *Engng*—Sept. 7, 1900. No. 36-459 A.

Sailing Vessels.

The New Era of the American Sailing Vessel. Waldon Fawcett. An illustrated account of large steel sailing vessels and five and six masted wooden schooners recently built at Bath, Me. 2000 w. *Sci Am*—Sept. 22, 1900. No. 36581.

Types of Sailing Craft. Discusses how they are dressed in different parts of the world, and considers the schooner rig destined to be the sea-going ship of the future. 2400 w. *Marine Rev*—Aug. 30, 1900. No. 36208.

Steamer.

Mammoth Lake Steamer. Illustration and description of the "Lafayette," one of five new 474-ft. vessels for the Carnegie Line. 1100 w. *Naut Gaz*—Sept. 6, 1900. No. 36345.

Passenger and Freight Steamer "Hartford." Built for the New York & Hartford Transportation Co. Illustration, with description, of a twin-screw steel vessel of 1,488 gross registered tons and having a cargo capacity of about 300 tons of freight, and accommodations for from 250 to 350 passengers. 1500 w. *Marine Engng*—Sept., 1900. No. 36258 C.

Stern Wheel Missionary Steamer "Samuel N. Lapsley." Illustrates and describes a light-draft, stern-wheel boat for use on the Congo River. 500 w. *Marine Engng*—Sept., 1900. No. 36262 C.

The Type of Steamships Years Ago. Illustration and brief description of the "Savannah," the first vessel to cross the Atlantic under steam. 500 w. *Am Ship-builder*—Sept. 13, 1900. No. 36394.

Thames Steamboats.

The Thames Passenger Steamboat Service. Reviews the origin and history of the late passenger traffic on this river, the kind of vessels and machinery that

have been in use, etc. Ill. 4000 w. Engr, Lond—Aug. 24, 1900. Serial. 1st part. No. 36245 A.

Torpedo.

Improved Directing Device for Torpedoes (Le Nouvel Appareil Directeur pour Torpilles Automobiles). H. Noalhat. Describing the Whitehead and the Howell torpedoes and the Obry gyroscopic device for guiding the former. 3500 w. Revue Technique—Aug. 25, 1900. No. 36615 D.

Torpedo Boats.

Torpedo Craft—United States and Foreign—Types and Employment. R. H. Jackson. Prize essay read before the U. S. Naval Inst., Annapolis, Ind. 1300 w. Marine Engng—Sept., 1900. Serial. 1st part. No. 36264 C.

Troopship.

Launch of Troopship "Hardinge." A general description of a British troopship, recently launched on the Clyde. 1300 w. Marine Rev—Sept. 13, 1900. No. 36438.

Tugboats.

New Harbor Tugboats. Illustration, with description, of one of the three powerful vessels added to the Pennsylvania R. R. Co.'s fleet. 1300 w. Naut Gaz—Aug. 30, 1900. No. 36219.

Tug "Richard Croker," for Dock Dept., City of New York. Illustration, drawings and description of a steel tug well equipped for harbor service. 1800 w. Marine Engng—Sept., 1900. No. 36260 C.

Ventilator Cowsls.

A Practical Geometrical Method of Laying Out Ship Ventilator Cowsls. C. M. Jones. Describes method of development. 2000 w. Marine Engng—Sept., 1900. No. 36263 C.

War Vessels.

Best Types of War Vessels. A naval prize essay by Major C. Field, in the *Journal of the Royal United Service Institution*, on the essential requirements and characteristics of fighting ships for the British Navy. 5000 w. Marine Rev—Sept. 20, 1900. No. 36863.

Yachts.

The Clyde and Palatial Steam Yachts. A short general description of Bennett's "Lysistrata" and Drexel's "Margarita," built on the Clyde. 700 w. Engr, Lond—Sept. 14, 1900. No. 36700 A.

The Steam Trials of the New Royal Yacht. A short account of the contract trials of the "Victoria and Albert," with table of results. 1100 w. Engng—Sept. 7, 1900. No. 36458 A.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Congress.

International Automobile Congress. Abstract from report on the details of construction of vehicle frames and their parts made by A. Bollée, Sr., to the third section of the Congress. Touches on piping and pipe joints, loosening of nuts, and the use of aluminum and its alloys. 2000 w. Horseless Age—Sept. 12, 1900. No. 36390.

Electric Control.

Electric Automobile Control. An illustrated description of C. J. Coleman's controlling and driving mechanism. 1200 w. Elec Wld & Engr—Sept. 22, 1900. No. 36718.

Motor.

The Strickland Air-Cooled Motor. An illustrated description of a motor fitted to a tricycle. 400 w. Autocar—Sept. 8, 1900. No. 36527 A.

Postal Wagon.

Automobile Experiments of the German Postal Department. Abstract of an article in *Der Motorwagen*, giving the results of a nine-months' test of an electric vehicle for parcel delivery. 500 w. Horseless Age—Sept. 10, 1900. No. 36726.

Steam Cart.

Steam Tipping-Cart. Illustrated description of a cart made in Leeds, England. 700 w. Sci Am—Sept. 8, 1900. No. 36312.

Steam Dray.

Steam Dray of the Paul H. White Engineering Works. An illustrated description of a steam vehicle with a capacity of 4,000 to 6,000 pounds and a normal speed of five miles an hour. 500 w. Horseless Age—Sept. 19, 1900. No. 36524.

Steam Lorry.

American Built Thornycroft Steam Lorry. Illustrated description of vehicle built in Paterson, N. J. 900 w. Horseless Age—Aug. 29, 1900. No. 36187.

1,000 Mile Trials.

The Thousand-Miles Automobile Trials. W. Worby Beaumont. A critical review of the recent British trials, with illustrations of the principal vehicles, by one of the judges of the competition. 4500 w. Engineering Magazine—Oct., 1900. No. 36935 B.

Transmission.

The Leather Gasoline Vehicle. An ill-

Illustrated description of the vehicle. and particularly of the transmission gear. 700 w. Horseless Age—Sept. 19, 1900. No. 36525.

HYDRAULICS.

Centrifugal Pump.

The Centrifugal Emulsion Pump (Note sur les Pompes Centrifuges Emulsives). A. H. Courtois. A description of a modified form of centrifugal pump by which air may be introduced and mixed with the liquid. 2000 w. Revue de Mécanique—Aug., 1900. No. 36642 H.

Furnace Pump.

The Jeanesville Modern Furnace Pump. A short illustrated description of a pump for blast furnace purposes. 700 w. Ir Age—Sept. 20, 1900. No. 36522.

Pumping Engine.

See Steam Engineering.

Pumping Station.

Exposition of 1900. Pumping Station of the French Worthington Company (Exposition de 1900. Usine Elevatoire de la Société Française des Pompes Worthington). E. Cayla. A fully illustrated account of the Worthington pumping plant at the Paris Exposition. 3000 w. 2 plates. Génie Civil—Aug. 18, 1900. No. 36628 D.

MACHINE WORKS AND FOUNDRIES.

Annealing.

On the Annealing of White Cast-Iron. Charles James. An abstract of results obtained from daily business practice. 2800 w. Jour Fr Inst—Sept., 1900. No. 36291 D.

Boring.

A Convenient and Efficient Boring Bar. Illustrates and describes a boring bar and some of the uses to which it may be put. 900 w. Mach, N. Y.—Sept., 1900. No. 36222.

The Beaman & Smith Boring Machines. An illustrated description of three different types of large boring machines. 500 w. Ir Age—Sept. 27, 1900. No. 36755.

Bottle Stoppers.

Dies for Metal Bottle Stoppers. Joseph V. Woodworth. Illustrated detailed description. 1500 w. Am Mach—Sept. 6, 1900. No. 36310.

Cranes.

See Electrical Engineering, Power Applications.

Dividing.

Table for Spacing Holes in Circles. F. W. Seidensticker. A table of sides, angles at center, and sines for inscribed polygons up to 500 sides. 1600 w. Am Mach—Sept. 27, 1900. No. 36820.

Drill Jigs.

Hints on the Design of Drill Jigs and Milling Fixtures. E. H. Dodge. 1400 w. Am Mach—Sept. 6, 1900. No. 36311.

Electric Driving.

See Electrical Engineering, Power Applications.

Emery Wheels.

The Manufacture of Emery Wheels. Illustrates and describes the methods used at the Norton Emery Wheel Co.'s Works at Worcester, Mass. 2500 w. Ir Age—Sept. 6, 1900. No. 36301.

Foundry.

New Steel and Iron Foundry of the Sargent Company. Illustrates and describes the new works at Chicago Heights, and the Tropenas process of making steel. 1300 w. R R Gaz—Aug. 31, 1900. No. 36183.

Gun Making.

The Creusot Pavilion at the Paris Exhibition. An illustrated description of the ordnance and harbor improvement exhibits of Messrs. Schneider & Co. 3000 w. Engng—Sept. 14, 1900. No. 36590 A.

The Home of the Krupp Gun. C. E. Carpenter. A general account of the different Krupp works. 1500 w. Sci Am—Sept. 22, 1900. No. 36584.

The New Army 16-Inch Gun. An illustrated account of this great cannon and its manufacture at Watervliet Arsenal, New York. 1800 w. Sci Am—Sept. 29, 1900. No. 36811.

War Material at the Paris Exhibition. An illustrated account of the display, with comments. 1800 w. Engr, Lond—Aug. 31, 1900. No. 36361 A.

Lathes.

Lathes at the Paris Exhibition. A general review of the exhibit of lathes by all nations. 2100 w. Engng—Sept. 14, 1900. No. 36595 A.

Lathe Work Under a Flood of Water. Illustrates and describes the lathe, and gives examples of work. 1000 w. Am Mach—Sept. 13, 1900. No. 36373.

Mammoth Lathe for Turning Granite Columns. An illustrated description of a lathe which swings 6 feet 6 inches by 60 feet long. 1000 w. Ir Age—Sept. 20, 1900. No. 36520.

Malleable Castings.

Malleable Cast Iron. Outlines the process, giving something of the history of the industry. 3000 w. Eng & Min Jour—Sept. 8, 1900. No. 36322.

Micrometer.

Micrometer Heads for Special Gages. Illustrated description of these heads and various applications. 900 w. Am Mach—Sept. 13, 1900. No. 36374.

New Brown & Sharpe Measuring Instruments. An illustrated description of

micrometer calipers and gauges. 500 w. Ir Age—Sept. 27, 1900. No. 36759.

Mixing.

Mixing Irons. Edward Kirk. Suggestions for thoroughly mixing, and for mixing for a certain grade or class of work. 1500 w. Foundry—Sept., 1900. No. 36293.

Molding.

The Problem of Machine Molding. E. H. Mumford. Prepared for the meeting of the Foundrymen's Assn. Discusses why and how these machines should be used in foundries. 1800 w. Ir Trd Rev—Sept. 6, 1900. No. 36320.

Pipe Flanges.

Standard Pipe Flanges. A table of standard flanges, from the report of a committee of the American Society of Mechanical Engineers. 500 w. Am Mach—Sept. 27, 1900. No. 36816.

Riveting.

Upsetting Cold Steel Rivets by Hydraulic Pressure. Brief illustrated description of method employed in riveting the fly-wheels at the power plant of the Metropolitan St. Ry., in New York. 500 w. Mach, N. Y.—Sept., 1900. No. 36221.

Screws.

Rig for Making Little Screws on a Speed Lathe. Illustrated description. 800 w. Am Mach—Aug. 30, 1900. No. 36188.

Screw Threads.

Notes on the Computation of Screw Threads (Beiträge zur Schraubenberechnung). H. Camerer. With diagrams showing the various stresses and formulas for computation, including the influence of torsion. 2000 w. Zeitschr d Ver Deutscher Ing—Aug. 11, 1900. No. 36601 D.

Shops.

Cincinnati Milling Machine Co.'s Shops. E. M. Chace. Illustrated detailed description of these shops and their management. 2300 w. Mach, N. Y.—Sept., 1900. No. 36220.

Some Methods and Characteristics of a Berlin Tool Shop. Illustrated description of details of shop practice at the works of Ldw. Loewe & Co. 3200 w. Am Mach—Sept. 6, 1900. Serial. 1st part. No. 36309.

Spain.

Machine Tool Trade in Spain. J. H. Ball. Relates the conditions in Spain, and gives practical points on trade. 1700 w. Am Mach—Sept. 27, 1900. No. 36819.

Spiral Gears.

Designing Spiral Gears by the Quadrant Method. W. H. Croker. Descriptive article, with diagrams. 2000 w. Am Mach—Sept. 20, 1900. No. 36588.

Steel Castings.

See Mining and Metallurgy, Iron and Steel.

Tools.

Machine Tools. Part first gives an illustrated description of the exhibit of Smith & Coventry, Limited. 2500 w. Engr, Lond—Aug. 24, 1900. Serial. 1st part. No. 36247 A.

Tools for Interchangeable Work. Joseph V. Woodworth. Part first illustrates and describes a drilling jig. 700 w. Am Mach—Sept. 13, 1900. Serial. 1st part. No. 36375.

Tube-Making.

A New British Tube-making Process. An illustrated account of the Perrin process of making wrought iron tubes, which requires only two heats and two operations. 500 w. Ir & Coal Trds Rev—Sept. 14, 1900. No. 36778 A.

Wire Works.

The British Insulated Wire Co.'s Works at Prescott. Illustrated description of works for the manufacture of paper-insulated cables. 2800 w. Elec Rev, Lond—Aug. 31, 1900. Serial. 1st part. No. 36369 A.

Works Management.

Commercial Organization of the Machine Shop. Hugo Diemer. The fifth paper of Prof. Diemer's series includes the further discussion of the production department, with especial reference to accurate time-keeping. 3000 w. Engineering Magazine—Oct., 1900. No. 36934 B.

MATERIALS OF CONSTRUCTION.

Buckling.

The Correct Formula for Buckling (Die Richtige Knickformel). Correspondence between Messrs. Prandtl, Kriemler, and Kübler, discussing the new buckling formula of the latter engineer. 2000 w. Zeitschr d Ver Deutscher Ing—Aug. 26, 1900. No. 36604 D.

Corrosion.

The Relative Corrosion of Wrought Iron, Soft Steel, and Nickel Steel. Henry M. Howe. Abstract of paper read at the International Congress on "Methods of Testing the Materials of Construction," giving the results of experiments. 1800 w. Ir & Coal Trds Rev—Sept. 7, 1900. No. 36486 A.

Deformation.

Permanent Deformation of Metals. From a paper entitled *Phénomènes qui accompagnent la déformation permanente des métaux*, by Commander Hartmann, written for the Paris International Congress on Mining and Metallurgy. 2400 w. Col Guard—Sept. 7, 1900. No. 36445 A.

Stresses.

Ring Stresses and Tension Strength (Ringspannungen und Zugfestigkeit). M. Grübler. An examination of the relation between the tension resistance and the stresses in a ring, with especial reference to the researches of Professor Bach. 6000 w. *Zeitschr d Ver Deutscher Ing*—Sept. 1, 1900. No. 36606 D.

POWER AND TRANSMISSION.**Air Compressor.**

An Auxiliary Air Compressor for Steam Engines. An illustrated description of a compressor manufactured by the Sedgwick-Fisher Co., which can be conveniently and economically operated by the steam engine which supplies the motive power for a plant. 700 w. *Eng News*—Sept. 20, 1900. No. 36572.

The Use of Water Powers by Direct Air Compression. W. O. Webber. The revival of an old application by which a high efficiency is attained with simplicity of mechanism. 2500 w. *Engineering Magazine*—Oct., 1900. No. 36692 B.

Air Transmission.

Compressed Air for the Transmission of Power. J. H. Ronaldson. A paper before the New South Wales Chamber of Mines, giving a general discussion of compressed air, compressors, and methods of use. 3400 w. *Col Guard*—Sept. 14, 1900. No. 36768 A.

Compressed Air for Transmission of Power. J. H. Ronaldson. An account of the principles and the machinery employed. 2800 w. *Aust Min Stand*—July 26, 1900. No. 36382 B.

Conveyors.

Coal Handling Machinery. F. D. Marshall. A paper before the International Gas Congress at Paris, giving an illustrated account of Hunt conveying machinery used by Danish Gas Company at Copenhagen. 3000 w. *Gas Wld*—Sept. 8, 1900. No. 36475 A.

Continental Installations of the Hunt Transporter for Coal and Ore. From a paper by Engineer Aumond, before the German Ironmasters' Association, giving an illustrated account of the installation of this machinery of American design at various Continental works. 2000 w. *Col Guard*—Sept. 7, 1900. No. 36439 A.

Power Generation.

Power Generation. The Comparative Cost of Generating Power by the Steam Engine, Water Turbine and Gas Engine. J. B. C. Kershaw. Paper before the British Association, with elaborate data and tables. Serial. 1st part. 2500 w. *Engng*—Sept. 14, 1900. No. 36599 A.

Transporter.

A Phosphate Transporter at Sfax. An

illustrated description of a mechanical transporting plant which carries phosphate from stores and wagons to vessels at Sfax, Tunisia. 1100 w. *Sci Am*—Sept. 29, 1900. No. 36808.

SPECIAL MOTORS.**Banki Motor.**

Tests of the Banki Motor (Versuche am Banki-Motor). E. Meyer. A discussion of the data and results of this new internal combustion motor, showing the excellent results obtained. Illustrations showing the construction of the motor are given. 5000 w. *Zeitschr d Ver Deutscher Ing*—Aug. 11, 1900. No. 36600 D.

The Banki Motor and Other Heat Motors (Der Banki Motor und die Wärmemotoren). E. Schimanek. A general description of the Banki internal-combination motor, and a comparison of its performance with other motors; based on the recent tests. Three articles, 12000 w. *Zeitschr d Oesterr Ing u Arch Ver*—Aug. 10, 17, 24, 1900. No. 36620 each B.

Diesel Motor.

New Experiments on the Diesel Oil Engine. A short summary of tests at Augsburg, abstracted from a paper by Mr. Diesel at the Congrès de Mecanique at Paris. 900 w. *Engng*—Sept. 7, 1900. No. 36457 A.

Explosion Motors.

Explosion Motors at the Paris Exposition (Die Weltausstellung in Paris, 1900; Explosionsmotoren). Fr. Freytag. With numerous illustrations and descriptions of exhibited motors. Serial, part I. 2500 w. *Zeitschr d Ver Deutscher Ing*—Aug. 18, 1900. No. 36602 D.

Gas Engine.

A 600-H.-P. Two-stroke Cycle Gas Engine Using Blast-Furnace Gas. A well illustrated description, from the *Zeitschrift des Vereines Deutscher Ingenieure* of a gas engine using blast furnace gas. 1 plate. 1500 w. *Eng News*—Sept. 27, 1900. No. 36842.

Some Existing Gas-Driven Power Plants. Philip Dawson. A well illustrated article on the application of gas engines to drive electric power plants. Serial. 1st part. 1400 w. *Engng*—Sept. 7, 1900. No. 36451 A.

The Determination of the Efficiency of Port Valves of 4-Cycle Internal Heat Engines. Hugh D. Meier. A general discussion, and record of experimental tests, with indicator cards. 3000 w. *Horseless Age*—Sept. 19, 1900. No. 36523.

The Theory of Gas Engines (Essai sur la Theorie des Moteurs à Gaz). Jules Deschamps. An elaborate mathematical study, based upon the theory of Clausius. Serial, Part I. *Revue de Mecanique*—July, 1900. No. 36639 H.

Ignition.

Electrical Ignition of Gas Engines. H. J. Poddlesak. Discusses the methods of igniting the charges in a gas engine, especially favoring the inductor type of magneto-generators as a source of electric current for gas and vapor engine ignition. 4000 w. *Mod Mach*—Sept., 1900. No. 36256.

STEAM ENGINEERING.**Balancing.**

Balancing of Vertical Marine Engines Discussed in an Elementary Manner. J. Macfarlane Gray. Read before the Inst. of Marine Engs., London, Eng. Ill. 3000 w. *Marine Engng*—Sept., 1900. Serial. 1st part. No. 36261 C.

Boilers.

Defects Experienced in Belleville Boilers in the British Navy. An Admiralty statement as to the chief defects which have been experienced in the working of these boilers. 1000 w. *Eng News*—Sept. 20, 1900. No. 36547.

Double Steam Boiler with Conical Flues (Zwillings-Dampfkessel mit Conischem Stufenrohr). An illustrated description of an improved form of Lancashire boiler, exhibited at Paris. 800 w. *Glaser's Annalen*—Aug. 15, 1900. No. 36654 D.

The Boilers of the Paris Exposition. Illustrated detailed description of interesting exhibits. 5500 w. *Power*—Sept., 1900. No. 36181.

Boiler Tubes.

See *Railway Affairs, Motive Power.*

Calorimeter.

A New Form of Calorimeter for Measuring the Wetness of Steam. Prof. John Goodman. A paper before the British Association, giving an illustrated description of a continuous condensing calorimeter using only one scale beam. 2500 w. *Col Guard*—Sept. 14, 1900. No. 36764 A.

Chimneys.

Chimneys and Stacks for Steam Boilers. W. H. Wakeman. Calculations concerning chimney draft, with explanation. 3500 w. *Mod Mach*—Sept., 1900. No. 36257.

Coal Pockets.

The Design of Coal Pockets. Illustrated outline of the method of design adopted for the large power station of the Metropolitan Street Ry. in New York. 800 w. *Eng Rec*—Sept. 1, 1900. No. 36202.

Compression.

I. Regarding Effect of Compression in Steam Cylinders on Economy. B. C. Ball.
II. On the Compression of Back-Pressure

Steam Into the Waste Space of Cylinders. B. F. Isherwood. A criticism of reported tests, and a reply. 5000 w. *Jour Am Soc of Nav Engs*—Aug. 1, 1900. No. 36372 H.

Condensers.

Centralization of the Steam-Condensing Plant. H. G. V. Oldham. The first instalment of a very fully illustrated description of modern cooling towers, evaporative condensers, and general arrangement of central condensing plant. 4000 w. *Engineering Magazine*—Oct., 1900. No. 36693 B.

Cooling Tower.

A Cooling Tower Operating with Natural Draft. An illustrated description of a cooling tower brought out by the Wheeler Condenser & Engineering Co., which will cool water from 135° F. to 85° or 90° F. 200 w. *Eng News*—Sept. 27, 1900. No. 36845.

Corrosion.

Corrosion of Boiler Tubes in the United States Navy. Walter F. Worthington. Discusses the reasons usually assigned for the corrosion of boiler tubes, and gives results of experiments to determine the difference in corrodibility between the usual materials used, and general conclusions. Ill. 5400 w. *Jour Am Soc of Nav Engs*—Aug., 1900. No. 36371 H.

Economy.

See *Electrical Engineering, Generating Stations.*

Engines.

High Power Single-Cylinder Engines at the Paris Exhibition. E. Kilburn Scott. A short account of some large engines coupled to alternators. 700 w. *Elec Rev, Lond*—Sept. 7, 1900. No. 36498 A.

Some Notes on Inquiries for Engines. J. A. Seager. Suggestions for guidance and to facilitate the delivery of a satisfactory engine. 2200 w. *Am Gas Lgt Jour*—Sept. 3, 1900. No. 36280.

Steam Engines at the Paris Exposition (Die Weltausstellung in Paris, 1900; Die Dampfmaschinen). M. F. Gutermuth. A general review of the exhibited engines, with table showing varieties. Serial, Part I. 3500 w. *Zeitschr d Ver Deutscher Ing*—Sept. 1, 1900. No. 36605 D.

The Steam Engine. William Frederick Durand. An elementary discussion of the principles which govern the economical use of steam for the development of power. 3500 w. *Marine Engng*—Sept., 1900. Serial. 1st part. No. 36265 C.

The Sulzer Exhibit at the Paris Exhibition. A short illustrated description of some Sulzer engines, including a four-cylinder, triple-expansion one of 1,700 horse-power. 400 w. *Elec Rev, Lond*—Sept. 14, 1900. No. 36735 A.

Nigzell's Double Triple-Expansion Engine. An illustrated account of tests of a very well balanced engine, with diagrams. 2500 w. Engng—Sept. 7, 1900. No. 36460 A.

Exhaust-Steam.

Cooling with Exhaust Steam. Alton D. Adams. Discusses its utilization in the manufacture of ice or in the cooling of apartments near the steam plants. 2000 w. Am Arch—Sept. 1, 1900. No. 36253.

Exposition.

Power Plant at the Paris Exhibition. A well illustrated account of the exhibits in Machinery Hall. 10000 w. Ir & Coal Trds Rev—Sept. 7, 1900. No. 36487 A.

The Paris Exhibition Electric Power Station. The exhibits of Messrs. Escher, Wyss & Co., and Maschinenfabrik Oerlikon. A well illustrated description of a 1,000-horse-power horizontal engine, coupled with a triphase generator. 700 w. Engng—Sept. 7, 1900. No. 36454 A.

Feed-Heater.

The "Warwick" Feed-Heater and De-tartariser. An illustrated description of a feed water heater and purifier. 300 w. Engng—Sept. 14, 1900. No. 36596 A.

Indicator.

The Indicator and Revealer (Indicateur-Revelateur). G. Duchesne. A description of the method of testing the indicators used in the mechanical laboratory of the University of Liège; also of the revealer of Mr. Bryan Donkin for indicating the moisture in a steam cylinder. 4000 w. Revue de Mécanique—Aug., 1900. No. 36640 H.

Petroleum Fuel.

California Crude Petroleum as a Fuel. Ernest H. Denicke. Gives methods of burning oil and results of practical experience. Serial. 1st part. 2000 w. Min & Scien Press—Sept. 15, 1900. No. 36529.

Pulverized Coal.

The Burning of Pulverized Coal. Describes the use of pulverized coal in rotary kilns for burning Portland cement, and advocates its use under steam boilers. 600 w. Eng Rec—Sept. 15, 1900. No. 36415.

Pumping Engine.

Allis Triple-Expansion Pumping Engine, Chestnut Hill Station, Boston Water-Works. A brief illustrated description of a notable large high-duty engine. 1 plate. 250 w. Eng News—Sept. 27, 1900. No. 36850.

The Conditions of Maximum Pumping Engine Economy. A discussion of some recent tests of Allis and Nordberg engines, giving remarkable duty records; with tables. 4000 w. Eng News—Sept. 27, 1900. No. 36848.

Reciprocating Parts.

The Inertia of the Reciprocating Parts of a Steam Engine. C. H. Benjamin. The object of the article is to show the method of determining the excess and deficiency of energy for different speeds and points of cut-off. 2700 w. Mach, N. Y.—Sept., 1900. No. 36223.

Steam Turbines.

Report on Steam Turbines (Rapport sur les Turbines à Vapeur). M. Rateau. A paper presented at the Congrès de Mécanique at Paris, discussing mainly jet turbines of the de Laval type. 15000 w. Revue de Mécanique—August, 1900. No. 36643 H.

Stoking.

Mechanical Stoking. Illustrated description of the Playford mechanical stoker is given in part first. 1200 w. Sci Am Sup—Sept. 15, 1900. Serial. 1st part. No. 36387.

The Roney Mechanical Stoker. A well illustrated description of the improved form of this apparatus, which is to equip boiler plants of an aggregate of over 225,000 horse-power in the United States. 1000 w. Sci Am Sup—Sept. 22, 1900. No. 36585.

Notes on Firing (Etwas über Füllfeuerungen). Ed. Brauss. Gives various practical hints on fuel, furnaces, chimneys, etc. 1500 w. Gesundh Ing—July 15, 1900. No. 36558 B.

Thermodynamics.

Mean Effective Temperature a Unit of Comparison for Heat Engines. Chas. E. Lucke. A mathematical discussion of different cycles, with diagrams. 2000 w. School of Mines Quar—July, 1900. No. 36541 D.

Valve.

A New Balanced Piston-Valve and Its Application to Four-Crank Engines. Wm. O'Brien. Discussion of a paper before the Institution of Engineers and Shipbuilders in Scotland, at Glasgow. 700 w. Ir & Steel Trds Jour—Sept. 15, 1900. No. 36782 A.

Variable Load.

The Law of Averages—Simple vs. Compound Engines under Variable Load. W. H. Booth. A discussion of the relative advantages of single and compound engines under variable loads. 2300 w. Am Mach—Sept. 27, 1900. No. 36817.

MISCELLANY.

Air Ship.

The Zeppelin Air Ship as the Latest Experiment with Dirigible Balloons (Das Zeppelin Luftschiff als Neuester Versuch zur Lenkbarmachung von Gasballons). H. von Loessl. A general review of the attempts which have been made to steer gas

balloons, with reference to the recent experiments of Zeppelin. 3500 w. *Zeitschr d Oesterr Ing u Arch Ver*—Aug. 31, 1900. No. 36623 B.

British Association.

The British Association. Abstracts of the papers read in the Mechanical Science section at the Bradford meeting. 6000 w. *Engng*—Sept. 14, 1900. No. 36591 A.

The British Association. Address to the Mechanical Science section. Sir Alexander R. Binnie, President of Section. A historical review of mechanical science. Serial. 1st part. 2500 w. *Engng*—Sept. 7, 1900. No. 36461 A.

Competition.

American Engineering Competition. Notes on a series of articles recently published in the *London Times*. 2700 w. *Jour Gas Lgt*—Aug. 28, 1900. Serial. 1st part. No. 36249 A.

Liquid Air.

Linde's Liquid Air Machine. Alfred Siebert. How the machine operates to produce liquefaction, etc. 2300 w. *Ice & Refrig*—Sept., 1900. No. 36225 C.

Manufactories.

The Engineer, and the Economical Development of Manufactories. W. Arnold. Read before the Birmingham Assoc. of Engs., England. On the means of increasing the output and thus enabling England to compete with other countries. 6000 w. *Engr, Lond*—Aug. 31, 1900. No. 36363 A.

Mills.

The Origin of the Grinding Mill (*Les Origines du Moulin à Grains*). M. L. Lindet. A historical review with many illustrations of ancient and primitive mills. 12000 w. *Bull Soc d'Encour*—Aug., 1900. No. 36636 G.

Refrigeration.

A Brooklyn Refrigerating Plant. Illustrated description of the mechanical plant and insulating details of the building of a large cold-storage company. The plant provides for ventilation as well as refrigeration. 3500 w. *Eng Rec*—Sept. 1, 1900. No. 36203.

St. Louis Refrigerating and Cold Storage Co. Description of a new up-to-date plant, with exterior and interior views. 3800 w. *Ice & Refrig*—Sept., 1900. No. 36224 C.

Technical Education.

Chemical and Technical Education in the United States. Prof. C. F. Chandler. Presidential address before the Society of Chemical Industry, at London. Serial. 1st part. 7000 w. *Sci Am Sup*—Sept. 29, 1900. No. 36813.

Vibrations.

Mechanical-Technical Recreations (*Mechanisch-Technisch Plaudereien*). Dr. Holzmüller. A popular examination of the phenomena of vibration in connection with heat, illustrated with diagrams and formulas. 6000 w. *Zeitschr d Ver Deutscher Ing*—Aug. 18, 1900. No. 36603 D.

MINING AND METALLURGY

COAL AND COKE.

American Exports.

Exports of American Coal. The possibilities of the upbuilding of an immense trade pointed out by F. E. Saward, special U. S. Commissioner at Paris. 5000 w. *Marine Rev*—Sept. 20, 1900. No. 36862.

British Association.

Coal at the British Association. Abstracts of the principal papers relating to coal, such as, "The Origin of Coal," "Coal and Iron in China," etc. 3300 w. *Ir & Coal Trds Rev*—Sept. 14, 1900. No. 36775 A.

British Exports.

Coal and Iron Exports. An editorial giving figures for the British export trade in coal and iron for August, 1900, and for the first eight months of 1900. 500 w. *Col Guard*—Sept. 14, 1900. No. 36766 A.

Canada.

Canadian Mining Notes. A review of coal and iron ore production and trade.

1100 w. *Col Guard*—Sept. 14, 1900. No. 36770 A.

China.

The Coal and Iron Deposits of Shansi and Honan, China. J. G. H. Glass. Summary of a paper before the British Association, giving a description of the bituminous and anthracite coal fields of Shansi and Honan, existing means of communication, etc. 800 w. *Col Guard*—Sept. 14, 1900. No. 36773 A.

Coal-Cutting.

Some Difficulties of Electric Coal-Cutting. A detailed account of an attempt to cut coal by means of electric power in a Cape Colonial mine. 2000 w. *Col Guard*—Sept. 7, 1900. No. 36440 A.

Coal Question.

Coal Owners, Gas Companies, and the Coal Question. Concerning the scarcity of coal and high prices in England and on the Continent, and the importation of American coal. 1800 w. *Jour Gas Lgt*—Aug. 28, 1900. No. 36285 A.

Coal Supply.

The Coal Situation and the World's Coal Fields (*La Crise du Charbon*). A review of coal fields of the world, particularly new ones, and a consideration of international coal trade and transportation. 1000 w. *Moniteur Industriel*—June 9, 1900. No. 36569 E.

The World's Need of Coal and the United States' Supplies. F. E. Saward. A review of the changing conditions in the coal production of the world, showing the assured supply from the United States. 3500 w. *Engineering Magazine*—Oct., 1900. No. 36688 B.

Coke.

History of Connellsville Coke. F. C. Kieghley. Read before the Cent. Min. Inst. of W. Penna. 3200 w. *Foundry*—Sept., 1900. No. 36294.

Mining Methods in the Connellsville Coke Region. F. C. Kieghley. A fully illustrated account of the Pennsylvania coke industry, showing its importance as a factor in the production of iron. 4000 w. *Engineering Magazine*—Oct., 1900. No. 36690 B.

The Desulphurization of Coke. A general review of attempts to devise a satisfactory treatment. 1700 w. *Engr, Lond*—Sept. 7, 1900. No. 36462 A.

The Future of the Connellsville Coke Region. A review of conditions there and a discussion of length of time before the coal is exhausted. 800 w. *Eng & Min Jour*—Sept. 22, 1900. No. 36754.

Coke Ovens.

The Brunck Coke Ovens. R. Brunck, in *Stahl und Eisen*. Illustrated description, showing the method of packing in coal, and improvements in the recovery of gases and by-products. 1800 w. *Am Mfr & Ir Wld*—Sept. 6, 1900. No. 36328.

Colliers.

See *Marine Engineering*.

Colliery Managers.

The National Association of Colliery Managers. An account of the annual meeting at Sheffield, Eng., and the presidential address of John Knowles, reviewing the coal mining industry of Great Britain. 3000 w. *Col Guard*—Sept. 14, 1900. No. 36765 A.

English Collieries.

The Langwith and Clapwell Collieries. A general illustrated description of works near Chesterfield. 1700 w. *Col Guard*—Sept. 7, 1900. No. 36444 A.

Exposition.

Bruay Colliery at the Paris Exhibition. Illustrated description of a complete working model exhibited. 4300 w. *Col Guard*—Aug. 31, 1900. No. 36356 A.

Dourges Colliery at the Paris Exhibition. An illustrated description of a va-

riety of colliery apparatus exhibited by the Société des Mines de Dourges, in the department of Pas-de-Calais. 4000 w. *Col Guard*—Sept. 7, 1900. No. 36443 A.

France.

The Hard Coal Mines of Northern France (*Der Nord französische Stein Kohlenbergbau*). F. Drobniak. With some account of the methods of mining and timbering. 2000 w. 1 plate. *Oesterr Zeitschr f Berg u Hüttenwesen*—Aug. 25, 1900. No. 36673 B.

Fuel.

The Fuel Question in Sweden. A résumé of interesting articles on this subject which have appeared recently in the Swedish press. 1800 w. *Engr, Lond*—Aug. 31, 1900. No. 36360 A.

German.

The German Coal Industry. A review of the condition of the German coal industry during the past few months, when scarcity and high prices have prevailed. 2500 w. *Col Guard*—Sept. 14, 1900. No. 36769 A.

Haulage.

Electrical Coke Lorries. An illustrated description, with figures, showing the economy over horse haulage. 500 w. *Ir & Coal Trds Rev*—Sept. 7, 1900. No. 36484 A.

Electric Locomotives in Coal-Mining. An illustrated account of electric haulage at some Pennsylvania coal mines. 3400 w. *Engng*—Sept. 7, 1900. No. 36452 A.

Endless Rope Haulage at Pratt Mines. Illustrated description of a system installed in a mine at Ensley, Ala. 2700 w. *Ir Trd Rev*—Aug. 30, 1900. No. 36180.

Notes on the Compressed-Air Haulage-Plant at No. 6 Colliery of the Susquehanna Coal Company, Glen Lyon, Pennsylvania. J. H. Bowden. Descriptive. 1500 w. *Trans Am Inst of Min Eng*—Aug., 1900. No. 36339 D.

Kentucky.

The Kentucky Coalfields. Capt. C. C. Longridge. A general account of the fields, the character of the coal, the markets and transportation. 2000 w. *Col Guard*—Sept. 7, 1900. No. 36441 A.

Labor.

The Anthracite Coal Case. A discussion of the relative positions of miners and operators, with statistics. 2200 w. *Eng & Min Jour*—Sept. 29, 1900. No. 36855.

Lignite.

The Lignite Industry of the Cologne District (*Die Braunkohlenindustrie des Kölner Bezirkes*). H. Schott. A paper before the Society of German Engineers, giving a review of the production of lignite and the extent to which it has been used in Germany and elsewhere. 3000 w.

Zeitschr d Ver Deutscher Ing—Sept. 1, 1900. No. 36609 D.

Mine Maps.

Coal Mine Maps. L. C. Morganroth. An account of the systematizing of the maps of a large company. 1900 w. Eng & Min Jour—Sept. 29, 1900. No. 36857.

Origin.

The Conditions Under Which the Plants of the Coal Period Grew. A summary of papers read before the British Association, at Bradford, on the origin of coal, coal-period flora, etc. 3500 w. Col Guard—Sept. 14, 1900. No. 36771 A.

Outcrops.

Coal-Outcrops. Charles Catlett. Observations based on personal examinations. 1200 w. Trans Am Inst of Min Eng—Aug., 1900. No. 36338 D.

Poland.

The Production of Coal in the Dombrowa Region, Poland, for 1899 (L'Extraction Houillère du Bassin de Dombrowa (Pologne) en 1899). Official tables, taken from the *Torgovo-Promychlénaiä Gazeta*, giving figures for 1898 and 1899. 800 w. Moniteur Industriel—July 28, 1900. No. 36840 E.

Rhodesia.

Rhodesia's Coal Supply. A brief account of the Wankie coalfield. 300 w. Ir & Coal Trds Rev—Sept. 14, 1900. No. 36777 A.

Rib-Drawing.

Some Practical Remarks on Ribs and Rib-Drawing. W. S. Gresley. Considers the uneconomical and undesirable features attending taking out ribs and pillars. 4000 w. Eng & Min Jour—Sept. 1, 1900. No. 36213.

Silted Pipes.

Cleaning Silted Pipes. J. R. Wilkinson. Read before the Col. Mgrs. Assn. Deals with deposits more or less plastic, usually deposited from cold water in the rising mains of pumps or pipes. Ill. 1800 w. Ir & Coal Trds Rev—Aug. 31, 1900. No. 36355 A.

Staffordshire.

The Thickness and Character of the Coal Measures of North Staffordshire. W. Gibson. Summary of a paper before the British Association. 500 w. Col Guard—Sept. 14, 1900. No. 36774 A.

Survey.

The Geological Survey of the North Staffordshire Coalfield. Report of recent work, showing progress made. 3300 w. Col Guard—Aug. 31, 1900. No. 36358 A.

Trade.

The Coal Trade of the United States and the World's Coal Supply and Trade.

Abstract from the Summary for Commerce and Statistics, of U. S. Bureau of Statistics, for April, 1900, with diagram. 5000 w. Sci Am Sup—Sept. 22, 1900. No. 36387.

Wales.

The Geological Survey of the South Wales Coalfield. From the Summary of Progress of the Geological Survey of the United Kingdom for 1899. 5000 w. Col Guard—Sept. 7, 1900. No. 36442 A.

COPPER.

Arizona.

An Arizona Copper Exhibit at Paris. A description of several Arizona copper mines, their ores and smelters. 1600 w. Eng & Min Jour—Sept. 22, 1900. No. 36750.

Assaying.

The Assay of Copper Materials for Gold and Silver. L. D. Godshall. Discussion of this paper, which was presented at the Washington meeting, Feb., 1900. 1500 w. Trans Am Inst of Min Eng—Aug., 1900. No. 36344 D.

The Assay of Copper Materials for Gold and Silver. A. R. Ledoux. Criticism of a paper read by L. D. Godshall before the American Institute of Mining Engineers, and a description of the "combination method" used in assaying bar copper for silver. 1000 w. Eng & Min Jour—Sept. 15, 1900. No. 36410.

The Calorimetric Assay of Copper. J. D. Audley Smith. Gives details of method. 1000 w. Trans Am Inst of Min Eng—Aug., 1900. No. 36341 D.

The Calorimetric Assay of Copper. J. D. Audley Smith. Abstract of paper read at the Canadian meeting of the American Institute of Mining Engineers, describing a method of making a fresh set of standard colors for each batch of assays in the Heine "blue test" for copper. 1000 w. Eng & Min Jour—Sept. 15, 1900. No. 36409.

The Rapid Determination of Copper and Nickel in Sulphide Ores and Matte. Titus Ulke. A description of a method of analysis. 1000 w. Eng & Min Jour—Sept. 15, 1900. No. 36405.

Australia.

South Australian Mines. W. H. Mathews. The Inspector of Mines' report on the Poona and Mattapara copper mines, Paull's Consolidated Copper Proprietary and the Nilpena Copper Mine. 1200 w. Aust Min Stand—Aug. 2, 1900. No. 36384 B.

Deposits.

Types of Copper Deposits in the Southern United States. Walter H. Weed. An account of the copper resources of this region, describing examples of each type.

Ill. 17500 w. Trans Am Inst of Min Engs—Aug., 1900. No. 36342 D.

The Origin of the Native Copper in the Michigan Deposits. John F. Blandy. The writer's views as to the origin, and information relating to these deposits. 2000 w. Eng & Min Jour—Sept. 8, 1900. No. 36324.

Yukon.

Notes on the White Horse Copper Belt, Yukon Territory. R. H. Stretch. An account of the general surroundings and geological features. 2700 w. Eng & Min Jour—Sept. 8, 1900. No. 36323.

GOLD AND SILVER.

Amalgamation.

The Bryan Mill as a Crusher and Amalgamator Compared with the Stamp Battery. E. A. H. Tays. Discussion of this paper, which was presented at the California meeting, Sept., 1899. 700 w. Trans Am Inst of Min Engs—Aug., 1900. No. 36343 D.

Australia.

Phillips River Goldfield (W. Aus.). T. Blatchford. Extracts from the official report to the Mines Dept. on the geology of this district. 1700 w. Aust Min Stand—Aug. 2, 1900. Serial. 1st part. No. 36385 B.

Brazil.

Notes on Certain Schists of the Gold and Diamond Regions of Eastern Minas Geraes, Brazil. Orville A. Derby. Describes these deposits, giving analyses and discussing their origin. 4500 w. Am Jour of Sci—Sept., 1900. No. 36287 D.

British Columbia.

Notes from the Atlin District, British Columbia. W. M. Brook. An illustrated account of work on this gold field. 1200 w. Eng & Min Jour—Sept. 15, 1900. No. 36407.

The Quartz Lodes of the Atlin District. B. C. R. H. Stretch. A general description, with maps. 3200 w. Eng & Min Jour—Sept. 29, 1900. No. 36859.

Cyaniding.

Some Further Mill Practice in Cyaniding the Silicious Ores of the Black Hills, South Dakota. J. M. Henton. An account of operations at the mill of the Dakota M. & M. Co., at Central City. 1600 w. Mining & Scien Press—Sept. 8, 1900. No. 36448.

The Cyanide Works of the Liberty Bell Gold Mining Company, Colorado. F. L. Bosqui. An illustrated account of a cyanide plant with a capacity of 240 tons per day, with cost of operation. 900 w. Eng & Min Jour—Sept. 22, 1900. No. 36751.

Dredging.

Gold Dredging Experience in New

Zealand. A description of some working devices, and results of operations. 1000 w. Min Reporter—Sept. 13, 1900. No. 36530.

Georgia.

The Columbia Mining Company, Georgia. W. H. Fluker. An illustrated account of some Georgia gold mines. 1000 w. Eng & Min Jour—Sept. 22, 1900. No. 36752.

Nova Scotia.

Gold Mining in Nova Scotia. G. W. Stuart. A brief history of the industry, with illustrations. 2600 w. Eng & Min Jour—Sept. 15, 1900. No. 36413.

Old Mine.

The Oldest Gold Mining Camp. Theo. Van Wagenen. An illustrated account of some old gold workings on the California bank of the Colorado River, dating from the last century. 2000 w. Mining & Scien Press—Sept. 8, 1900. No. 36446.

Ontario.

The Gold-Fields of Western Ontario. J. D. Lowry. An account of the deposits, development, advantages, and other information. 1500 w. Eng & Min Jour—Sept. 1, 1900. No. 36212.

Pumping Plant.

Hydraulic Pumping-Plant on the Snake River, Idaho, for Power, Irrigation, and the Treatment of Gold Sands. John Birkimbine. Notes suggesting the application of available water power. 2000 w. Trans Am Inst of Min Engs—Aug., 1900. No. 36332 D.

Scorification.

Experiments Regarding the Influence of Silica on the Loss of Silver in Scorification. Lester Strauss. An account of experiments made and conclusions reached. 1600 w. Trans Am Inst of Min Engs—Aug., 1900. No. 36334 D.

Transvaal.

The Treatment of Gold Ore at the Transvaal Exhibit at the Trocadero. An illustrated account of a very interesting exhibit made by the government of the South African Republic. 1700 w. Sci Am Sup—Sept. 8, 1900. No. 36315.

Zinc-Bearing.

The Sadtler Process for Treating Zinc-Bearing Ores. A description of a process for the recovery of gold, silver, etc., from zinc-bearing ores. 2200 w. Eng & Min Jour—Sept. 29, 1900. No. 36858.

IRON AND STEEL.

Blast Furnaces.

Condition of the Blast Furnaces of the United States, September 1, 1900. Tables giving various statistics. 1000 w. Am Mfr & Iron Wld—Sept. 13, 1900. No. 36430.

British Trade.

Our Foreign Trade in Iron and Steel. Editorial on British imports and exports of iron and steel for the first eight months of 1899 and 1900. 900 w. *Ir & Coal Trds Rev*—Sept. 14, 1900. No. 36779 A.

Canada.

Canada as a Future Competitor in Coal and Iron. Concerning the iron ore resources of Nova Scotia and Ontario. 2200 w. *Ir & Coal Trd Rev*—Aug. 24, 1900. No. 36241 A.

Steel Shipments to Seaboard by All-Water Route. A discussion of the probable traffic between the Great Lakes and the seaboard, by way of the Canadian Waterways. 1700 w. *Ir Trd Rev*—Sept. 20, 1900. No. 36785.

China.

The Han-yang Steel Works, China. F. Lynwood Garrison. An account of the only iron and steel works of any importance in China, with illustration. 1000 w. *Ir Age*—Sept. 13, 1900. No. 36376.

Development.

National Ideals the Prime Influence in Iron Trade Development. H. J. Skelton. A discussion of the close relations between political and social order and the development of the iron trade. 3500 w. *Engineering Magazine*—Oct., 1900. No. 36689 B.

Export.

Reaching for Export Business. Pittsburgh iron and steel producers finding the way to reach the world's markets via the Welland Canal and the St. Lawrence River. 700 w. *Am Mfr & Iron Wld*—Sept. 13, 1900. No. 36434.

Exposition.

British Iron Trade Association. Report of the Secretary on Iron and Steel at the Paris Exhibition. A full report on the metallurgical and kindred exhibits at the Paris Exposition. Serial. 1st part. 8000 w. *Ir & Coal Trds Rev*—Sept. 14, 1900. No. 36780 A.

Paris Exposition—Exhibits in the Metallurgical Section. An illustrated account of various exhibits, principally iron and steel. 1500 w. *Sci Am Sup*—Sept. 29, 1900. No. 36812.

Furnace-Linings.

The Protection of Blast-Furnace Linings. S. S. Hartranft. Discussion of the best management, and comments on American practice. 1500 w. *Trans Am Inst of Min Engs*—Aug., 1900. No. 36336 D.

Iron Metallurgy.

Present State of Iron Metallurgy. From a communication to the *Revue Générale des Sciences*, by Emile Demenge, reviewing modern methods in metallurgy.

2200 w. *Col Guard*—Sept. 14, 1900. No. 36777 A.

Lake Superior.

Lake Iron Ore Matters. A Duluth letter discussing mines, prices, shipments, etc. 1500 w. *Ir Age*—Sept. 27, 1900. No. 36758.

Micrography.

The Causes of Fracture of Steel Rails. An illustrated abstract of the report of a Board of Trade Committee of Investigation into the loss of strength of steel rails by prolonged use, particularly the microscopical examination of a broken rail. 1200 w. *Nature, Lond*—Sept. 6, 1900. No. 36449 A.

Nova Scotia.

The Outlook for an Iron and Steel Industry in Nova Scotia. A discussion of present conditions and future developments. 2200 w. *Eng News*—Sept. 13, 1900. No. 36420.

New South Wales.

Iron Ore in New South Wales. Extracts from a preliminary report by J. B. Jaquet, Geological Surveyor to the New South Wales Mines Department, upon deposits of iron ore in the Carcoar district. 1000 w. *Col Guard*—Sept. 14, 1900. No. 36772 A.

Nickel Steel.

Nickel Steel at the Exposition of 1900 (*Les Aciers à Nickel à l'Exposition de 1900*). A. Abraham. An account of the exhibits at Paris, and a discussion of the researches of M. Guillaume. 3000 w. *Génie Civil*—Aug. 11, 1900. No. 36626 D.

Norway.

The Possibility of an Iron Industry in Norway. H. C. Carpenter. A review of Prof. J. H. L. Vogt's estimate of the cost of making pig-iron in Norway. 1000 w. *Eng & Min Jour*—Sept. 29, 1900. No. 36860.

Open-Hearth.

Development in Open-Hearth Steel. R. C. Lauth. Suggestions that might lead to great results in cheapening the cost. 2000 w. *Am Mfr & Ir Wld*—Sept. 6, 1900. No. 36329.

Ores.

The Clealum Iron-Ores, Washington. George O. Smith and Bailey Willis. Gives the general features, geology, and hypothesis concerning the origin, with short discussion. Map. 3300 w. *Trans Am Inst of Min Engs*—Aug., 1900. No. 36331 D.

Pig Iron.

A Device for Sampling Pig-Iron. Porter M. Shimer. A paper read before the American Institute of Mining Engineers, giving an illustrated description

of a small cup, fitted to a break-drill, to catch the drillings. 400 w. Eng News—Sept. 27, 1900. No. 36847.

Distribution of the World's Production of Pig-Iron. John Birkinbine. A statement giving a general idea of amounts as compiled from latest official records, of ores, iron, and metals produced in the various countries that contribute to the output. 6000 w. Trans Am Inst of Min Eng.—Aug., 1900. No. 36333 D.

Pig Iron Production, Prices and Prospects. Tables and curves showing statistics for the last three years, and also a comparison, with statistics, for 1879-80. 2200 w. Eng News—Sept. 20, 1900. No. 36549.

Rolling Mills.

Modern Practice in Rolling Mill Driving (Neue Gesichtspunkte und Erfahrungen im Walzwerks betriebe). H. Ehrhardt. With especial reference to the rolling mill engines exhibited at Paris. 1500 w. Stahl und Eisen—Sept. 1, 1900. No. 36645 D.

Power Consumption of Rolling Mills. A report of tests of the power consumed on various operations, made at a steel works on the Continent. 700 w. Ir Age—Sept. 13, 1900. No. 36377.

Roll-Relieving Device. An illustrated description of a quick and simple roll-relieving mechanism in use at the Lukens Iron & Steel Co.'s works, invented by Chas. L. Huston. 700 w. Ir Trd Rev—Sept. 20, 1900. No. 36784.

Three-High Rolls (Ueber Trio Walzen). Fr. Horn. An examination of the correct dimensions and forms of passes in rolls for three-high rolling mills. 1800 w. Stahl und Eisen—Sept. 1, 1900. No. 36646 D.

Solution Theory.

Contributions to the Solution Theory of Iron and Steel (Beiträge zur Lösungstheorie von Eisen und Stahl). H. Juptner von Jonstorff. A further contribution to the physical chemistry of steel and iron, with numerous examples in support of the solution theory. 2000 w. Stahl und Eisen—Sept. 1, 1900. No. 36647 D.

Steel Castings.

Steel Castings. From a paper by M. Tissot before the International Congress on Mining and Metallurgy, Paris, giving a review of the subject. 1200 w. Ry & Eng Rev—Sept. 22, 1900. No. 36834.

Steels.

Special Steels. L. Babu. From a paper prepared for the Min. & Met. Cong., at Paris. Considers the making, working, hardening and annealing. 2500 w. Col Guard—Aug. 24, 1900. No. 36237 A.

Tilly Foster.

The Tilly Foster Mine. Edward K. Landis. Gives the history of this iron

mine and the method of working. 1000 w. Jour Fr Inst—Sept., 1900. No. 36290 D.

Trade Prospects.

Iron and Steel Prospects. An editorial discussing the situation in the British iron and steel trade, as affected by American and German competition, with diagrams. 1800 w. Engng—Sept. 7, 1900. No. 36456 A.

Ural.

The Iron Industry in the Ural (L'Industrie du Fer dans l'Oural). P. Kouindjy. A complete review of the subject, based upon official reports and issued by the Russian Ministry of Finance. 8000 w. Bull Soc d'Encour—July, 1900. No. 36635 G.

MINING.

Excavator.

An Excavating and Loading Machine for Transferring Ore to Railway Cars. A short illustrated description of a machine made by the Jeffery Manufacturing Co. for the Fayal Iron Co., of Minnesota. 250 w. Eng News—Sept. 20, 1900. No. 36570.

Explosives.

Safety Explosives at the Paris Mining Congress (Die auf dem Internationalen Kongress für Bergbau und Hüttenwesen zu Paris Gehaltenen Vorträge über Sicherheitssprengstoffe). H. Heise. A report of the discussions at Paris on safety mining explosives. 3000 w. Glückauf—Aug. 25, 1900. No. 36669 B.

Lamps.

Report on the Investigation of Mining Lamps (Bericht über die auf Berggewerkschaftlichen Versuchstation bisher Ausgeführten Lampenuntersuchungen). H. Fähndrich. A report of tests of various mining lamps with respect to their capacity for igniting mine gases. 5000 w. Glückauf—Sept. 15, 1900. No. 36671 B.

Miners.

The Miner in Yorkshire and South Africa; His Income and Expenditure Compared. Tabulated statement and interesting comparison. 1300 w. Col Guard—Aug. 24, 1900. No. 36235 A.

Mining Law.

Some Recent Cases on the Law of Support. Some cases on damage caused by subsidence as recently decided in English courts. 2000 w. Col Guard—Aug. 31, 1900. No. 36357 A.

Safety.

Personal Safety in Electric Mining Plants (Die Persönliche Sicherheit bei Elektrischen Anlagen in Bergwerken). W. Philippi. With details as to the isolation of conductors, protection of generators and motors, and the ignition of fire-damp. 4000 w. Glückauf—Aug. 18, 1900. No. 36668 B.

Shaft Sinking.

The Simultaneous Sinking and Walling of Shafts (Fonçage et muraillement Simultanés d'un Puits). Describing the method employed by M. Matheron at the Boule mines. The masonry was built in sections as the shaft was sunk. 1200 w. Génie Civil—Aug. 18, 1900. No. 36630 D.

Tasmania.

Tasmanian Mining Affairs. E. Mulcahy. A ministerial statement of policy and progress, with editorial comment. 4200 w. Aust Min Stand—Aug. 2, 1900. No. 36383 B.

Temperature.

The Temperature of the Strata of the Ruhr Coal Basin (Ueber die Temperatur der Gebirgsschichten des Ruhrsteinkohlenbeckens). H. Kette. With diagrams and tables based on numerous observations, showing the relation of temperature and depth. 4000 w. 2 plates. Glückauf—Sept. 1, 1900. No. 36670 B.

Ventilation.

Loss of Load Due to the Motion of Air in Mine Shafts. From a communication by M. Paul Petit to the International Mining and Metallurgical Congress at Paris on calculating the loss of load in order to arrive at the total depression required for ventilating the face of a heading. 3000 w. Col Guard—Sept. 14, 1900. No. 36762 A.

Substitution of Convergent-Divergent Adjutages for Wickets in Mine Ventilation. Paul Petit. From a paper prepared for the Min. & Met. Cong., Paris. An illustrated account of experimental investigations, with conclusions. 3000 w. Col Guard—Aug. 24, 1900. No. 36236 A.

MISCELLANY.**Abrasives.**

The Production of Abrasives. From the annual report of the United States Geological Survey, compiled by E. W. Parker, giving production of mineral abrasives and also carborundum and crushed steel. 1500 w. Ir Age—Sept. 20, 1900. No. 36521.

Aluminum.

Aluminum at a Moderate Price. M. Heroult. Abstract of a paper before the International Congress of Mining and Metallurgy at Paris, giving a general account of the Heroult, or Hall, electrolytic process, with a brief review of the advance made in methods of producing aluminum. 1200 w. Eng & Min Jour—Sept. 15, 1900. No. 36408.

Assaying.

The Assay Practice of the West Compared with That of the School of Mines. Charles Fulton. An account of methods used in both places. 1200 w. School of Mines Quar—July, 1900. No. 36542 D.

Brass.

The Properties of Brass Made from Copper Containing Sub-Oxide, with Observations of the Effect of Oxygen on Copper. Edwin S. Sperry. An account of experimental investigations, concluding that unless the amount of oxygen is large it cannot be called an injurious impurity. 4000 w. Trans Am Inst of Min Engs—Aug., 1900. No. 36337 D.

Diamonds.

The Diamond Industry of the Cape. (L'Industrie Diamantifere au Cap). F. Schiff. A discussion of the geology and working details of the diamond mines of the Cape of Good Hope. 2500 w. Génie Civil—Aug. 18, 1900. No. 36629 D.

Fuller's Earth.

The Occurrence of Fuller's Earth in the United States. David T. Day. Considers the characteristics and the development of the industry in the United States. 2200 w. Jour Fr Inst—Sept., 1900. No. 36289 D.

Lead.

Blast Furnace Slags in Lead Smelting. C. C. Longridge, in London *Mining Journal*. How to secure good separation, giving the composition of several useful slags, and discussing the effect of various constituents. 1500 w. B. C. Min Rec—Sept., 1900. No. 36351 B.

Manganese.

Manganese Mining. C. H. Vannier. Discusses the valuable properties of manganese, and gives an illustrated account of the Crimora mines in Virginia. 1100 w. Mod Mach—Sept., 1900. No. 36255.

The Manganese Ore Trade of Russia. Solon J. Vlasto. An account of the manganese ore industry in the Caucasus. 1400 w. Eng & Min Jour—Sept. 22, 1900. No. 36753.

Mica.

Mica Mining in India and the United States. An illustrated account of mica mining in India. 1100 w. Mining & Science Press—Sept. 8, 1900. No. 36447.

Petroleum.

Applications of Petroleum in Metallurgy, and in Glass Manufacture (Applications du Pétrole à la Metallurgie et à l'Industrie du Verre). G. de Krivochapkin. Showing especially the Nobel grate as applied to reverberatory furnaces. 1500 w. Génie Civil—Aug. 25, 1900. No. 36632 D.

Roumanian Petroleum (Rumänisches Erdöl). J. Tanasescu. An account of the physical and chemical properties of Roumanian petroleum. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 18, 1900. No. 36672 B.

Petroleum Industry of Canada. John D. Noble. Paper before the International

Petroleum Congress, Paris, on the oil wells in the Petrolia district, and methods of boring, storage and drilling. 2400 w. *Am Gas Lgt Jour*—Sept. 24, 1900. No. 36789.

Platinum.

Notes on the Occurrence of Platinum in North America. David T. Day. Gives results of careful examination and inquiry, the conditions of occurrence, etc. 1900 w. *Trans Am Inst of Min Eng*—Aug., 1900. No. 36335 D.

Potassium.

Mining Potassium Salts in Germany. E. Mackey-Heriot. A short description of the deposits, geology, etc. 1000 w. *Eng & Min Jour*—Sept. 1, 1900. No. 36211.

Quarrying.

The Helicoidal Wire System of Quarrying. N. Pellati. Abstract of a paper before the International Congress of Mining and Metallurgy in Paris, describing a method of making cuts in marble and other stone with a wire-cord formed of three hard steel wires twisted together with a very slow pitch. 1100 w. *Eng & Min Jour*—Sept. 15, 1900. No. 36406.

Russia.

Foreign Capital in Russian Industrial Undertakings. An article from the *Financial Chronicle*, reviewing the part taken by foreign investors in the development of Russia. 1100 w. *Ir Age*—Sept. 27, 1900. No. 36757.

Mining and Metallurgy in South Russia (Le 24 Congrès de l'Industrie Minérale

du Sud de la Russie). An account of the proceedings of a meeting of those engaged in mining and metallurgy in South Russia, with statements about the coal, iron and other industries, and lines of communication. 2500 w. *Moniteur Industriel*—May 26, 1900. No. 36566 E.

Shale Oil.

The Oil-Bearing Shales of the Coast of Brazil. John C. Branner. Describes the material and the width of the belt at various places, the exposures, etc. Ill. 3800 w. *Trans Am Inst of Min Eng*—Aug., 1900. No. 36340 D.

Smelter.

The Smelting Corporation's Works at Ellesmere Park, England. J. L. F. Vogel. An account, with illustrations, of the Fry process of treating zinc-lead sulphides. 2500 w. *Eng & Min Jour*—Sept. 29, 1900. No. 36856.

Spain.

The Mining Industry in Spain (De l'Industrie des Mines en Espagne). A serial article giving a general review of mines and mining in Spain. Serial. 1st part. 1000 w. *Moniteur Industriel*—June 23, 1900. No. 36836 E.

Uranium.

Uranium and Its Ores. J. Ohly. Describes the ores and some of the uses. 1600 w. *Min & Sci Pr*—Aug. 25, 1900. No. 36194.

Zinc.

See Electrical Engineering, Electro-Chemistry.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

A Year's Railway Accidents. Extracts from Mr. Hopwood's report to the British Board of Trade on railway accidents during 1899. 1700 w. *Transport*—Sept. 14, 1900. No. 36830 A.

Fast Trains.

Long and Fast Railroad Runs. Tables from the London *Engineer* of British, American and French fast trains, running 100 miles and upwards. 900 w. *R R Gaz*—Sept. 28, 1900. No. 36801.

Long-Distance Railway Runs. A comparison of long-distance fast trains in England, America and France, with tables. 1000 w. *Engr, Lond*—Sept. 7, 1900. No. 36463 A.

The Fastest Trains of the World in 1899. Four tables of American, French and British fast trains, reprinted from the London *Times* of Aug. 17, 1900, with com-

ment. 1800 w. *R R Gaz*—Sept. 21, 1900. No. 36579.

M. C. B. Rules.

Revision of the M. C. B. Rules of Interchange. Changes made at the annual convention of the M. C. B. Assn., to take effect Sept. 1, 1900. 900 w. *R R Car Jour*—Sept., 1900. No. 36378.

Spain.

Railways in Spain. A general account of Spanish railways. 1800 w. *Sci Am Sup*—Sept. 22, 1900. No. 36586.

FINANCIAL.

French Railways.

Earnings and Operating Expenses of the French Railways for 1899 (*Chemins de Fer Français Recettes et Dépenses d'Exploitation en 1899*). Abstracts of company reports, with table of gross earnings and operating expenses. 1000 w. *Moniteur Industriel*—June 2, 1900. No. 36567 E.

Purchase.

The Government Purchase of the Great Indian Peninsula Railway. Information concerning the causes of delay in the acquisition, and related matter. 1500 w. Transport—Aug. 31, 1900. No. 36330 A.

MOTIVE POWER AND EQUIPMENT.**Acetylene.**

See Gas Engineering.

Boiler Tubes.

Long Tubes for Locomotive Boilers. Geo. L. Fowler. Letter making a brief review of the state of the art, and giving a short summary of available data on the subject. 1500 w. R R Gaz—Sept. 21, 1900. No. 36573.

Brakes.

Inertia Brake Attachment. An illustrated description of an apparatus designed by H. H. Westinghouse, in which the inertia of a weight acts to increase the braking pressure. 600 w. Ry & Eng Rev—Sept. 22, 1900. No. 36835.

The Electrical Control of Air Brakes. (Ueber eine Elektrische Steuerung von Luftdruckbremsen). H. Wagner. Describing an electrical attachment for use with the Westinghouse brake, enabling greater promptness in braking to be made. 3500 w. Glaser's Annalen—Sept. 15, 1900. No. 36658 D.

Brake Shoes.

Mr. S. P. Bush on Brake Shoes. Abstract of remarks before the Western Railway Club, by the chairman of the M. C. B. Brake Shoe Committee, on the development of high power brake shoes. 500 w. R R Gaz—Sept. 28, 1900. No. 36802.

The Effect of Temperature on the Friction of Brake Shoes. From a paper by Prof. R. A. Smart before the Western Railway Club, giving the results of experiments, with curves. 1700 w. R R Gaz—Sept. 28, 1900. No. 36804.

The Friction of Brake Shoes Under Various Conditions of Pressure, Speed and Temperature. R. A. Smart. Abstract of a paper before the Western Railway Club, giving the results of tests made at Purdue University. 1800 w. Eng News—Sept. 27, 1900. No. 36851.

Cars.

An English Private Car. Illustrated description of a private car for the Duke of Sutherland, L. & N. W. R. R., England. 400 w. R R Car Jour—Sept., 1900. No. 36381.

An Epoch in Railroad Transportation. Henrik V. Van Z. Loss. Extracts from a paper for the Paris International Railroad Congress, calling attention to the advantages of pressed steel cars. 2500 w. R R Gaz—Sept. 28, 1900. No. 36805.

80,000-Pound Side-Dump Cars. Draw-

ings and description of fifty cars recently built for the transporting of coal, ore and ballast on the C. L. and W. Ry. 700 w. Am Eng & R R Jour—Sept., 1900. No. 36281 C.

The Pressed Steel Car. From a paper by Sumner B. Ely before the Engineers' Society of Western Pennsylvania, giving an illustrated account of pressed steel and pressed steel cars. 2000 w. Ir Age—Sept. 27, 1900. No. 36760.

Draw Gear.

Some Observations on Draw Gear. George S. Hodgins. Calling attention to defects, and changes needed. 1400 w. R R Car Jour—Sept., 1900. No. 36379.

Elevator.

Automatic Ash Elevator. Illustrates and describes an arrangement for handling locomotive ashes. 700 w. Am Engr & R R Jour—Sept., 1900. No. 36284 C.

Engineers' Association.

The Traveling Engineers' Association. A notice of the Cleveland meeting, with abstracts of the reports of various technical committees. 4000 w. R R Gaz—Sept. 21, 1900. No. 36574.

Exposition.

At the Paris Exposition. The United States Transportation exhibits at Vincennes illustrated and described. 2000 w. Ry Age—Sept. 14, 1900. No. 36477.

Locomotive Exhibits at Vincennes. Charles Rous-Marten. A general review of the exhibits. 2200 w. Engr, Lond—Sept. 14, 1900. No. 36701 A.

Paris Exposition. American Cars and Car Supplies in the Transportation Building. An illustrated account of American exhibits at Paris. 1800 w. Ry Age—Sept. 21, 1900. No. 36829.

The Collective Exhibit of the North German Car Building Association (Kollektivausstellung der Norddeutschen Wagenbau-Vereinigung). A fully illustrated description of the various railway carriages exhibited at Paris. Two articles. 6000 w. 5 plates. Glaser's Annalen—Sept. 1, 15, 1900. No. 36657 each D.

Feed-Water Purification.

Purification of Feed-Water. J. A. F. Aspinwall. Abstract from a report on the "Purification of Feed-water of Locomotives and the Use of Disincrustants," prepared for the International Railway Congress. 1800 w. Ir & Coal Trds Rev—Sept. 7, 1900. No. 36483 A.

Journal Box.

The Proposed 5½ by 10 M. C. B. Journal Box. F. M. Whyte. A criticism, with replies. Ill. 1100 w. Am Engr & R R Jour—Sept., 1900. No. 36283 C.

Lights.

Back Lights. W. H. Lane. Read be-

fore the Ry. Sig. Club. Discusses the dangers due to present practice in the use of signal lights, and the means of overcoming them. 1200 w. Ry & Engng Rev—Sept. 8, 1900. No. 36354.

Locomotive Painting.

Painting of Pennsylvania Railroad Locomotives. C. H. Caruthers. Describes the practice of this road. 1000 w. R R Gaz—Aug. 31, 1900. No. 36186.

Locomotives.

Compound Express Locomotive (Locomotive Compound Express). F. Barbier. An illustrated account of the Krauss locomotive exhibited at Paris, with auxiliary driving mechanism on the forward truck. 2000 w. 1 plate. Génie Civil—Aug. 11, 1900. No. 36625 D.

Compound High Speed Locomotives of the Northern Railway of France (Locomotives Compound à Grand Vitesse des Chemins de Fer du Nord Française). F. Barbier. Illustrating and describing in detail the powerful four-cylinder compound express locomotives of M. der Bousquet for the Northern Railway of France. 2000 w. 1 plate. Génie Civil—Aug. 25, 1900. No. 36631 D.

Decapod Compound Locomotive for the Minneapolis, St. Paul & Sault Ste. Marie Ry. An illustrated description of a locomotive with five pairs of driving wheels, guaranteed to haul a train load of 2000 tons, built by Baldwin Locomotive Works. 1000 w. Eng News—Sept. 20, 1900. No. 36545.

Details of Class "D" Passenger Locomotives of the Chicago & Northwestern. A well illustrated description of details. R R Gaz—Sept. 21, 1900. No. 36575.

Early Locomotive Building in Massachusetts. Herman L. Morse. Review of work of several firms. 2500 w. Loc Engng—Sept., 1900. No. 36190 C.

Fast Heavy Passenger Service on the Central Railroad of New Jersey. An account of a trip between Asbury Park and Jersey City, with illustration of engine. 900 w. Loc Engng—Sept., 1900. No. 36191 C.

Four-Cylinder Compound Locomotives in France. Abstract of a paper by Edouard Sauvage, before the Institute of Mechanical Engineers, on "Recent Locomotive Practice in France," giving descriptions of different types of four-cylinder compound locomotives, with tables and illustrations. 3600 w. R R Gaz—Sept. 28, 1900. No. 36799.

French Four-Cylinder Compounds. An editorial discussion of the compound type of locomotive. 1800 w. R R Gaz—Sept. 28, 1900. No. 36806.

German Locomotives at the Paris Exhibition. Begins an illustrated description of the exhibit of the Sächsische Maschinenfabrik, of Chemnitz. 250 w. Engng—

Aug. 24, 1900. Serial. 1st part. No. 36239 A.

German Locomotives at the Paris Exhibition. Compound Locomotive for the Royal Bavarian Railways, Constructed by Messrs. Maffei & Co., Munich. A very well illustrated description of an articulated locomotive on the Mallet system. 1 plate. 800 w. Engng—Sept. 7, 1900. No. 36455 A.

Heavy Consolidation Locomotive for the Illinois Central Railroad. A well illustrated description of a 218,000-pound locomotive for hauling 3,000-ton trains, built by Rogers, at Paterson, N. J. 900 w. Engng—Sept. 14, 1900. No. 36593 A.

Italian Locomotive at the Paris Exhibition. An illustrated description of a six-coupled compound locomotive of the Mediterranean Railway Co. 700 w. Engng—Sept. 14, 1900. No. 36597 A.

New "Highland" Locomotive. Illustration and brief description of new ten-wheel express engine for Highland Ry., of Scotland; one of the "Castle" class. 300 w. Loc Engng—Sept., 1900. No. 36189 C.

Richmond Consolidation Locomotive, Rio Grande Western Ry. Illustrates and describes heavy locomotives, eight of which have been received and are in service, giving satisfactory results. 1200 w. Ry & Engng Rev—Sept. 1, 1900. No. 36286.

Ten-Wheeled Express Locomotive for the Highland Railway. An illustrated description of a powerful type of passenger locomotive, built in Glasgow. 500 w. Transport—Sept. 7, 1900. No. 36429 A.

Ten-Wheel Passenger Engine for Chicago, Rock Island & Pacific. Illustration and general dimensions. 200 w. Loc Engng—Sept., 1900. No. 36192 C.

The Mallet Articulated Compound Locomotive. Abstract of a paper by M. A. Mallet in the *Revue Generale des Chemins de fer*, describing the progress in the use of this four-cylinder locomotive, all of whose wheels are drivers, with illustration. 900 w. R R Gaz—Sept. 14, 1900. No. 36424.

The Paris Exhibition. Borsig Locomotive, with Superheater. A well illustrated description of a powerful locomotive fitted with a superheater constructed under the Wm. Schmidt patent. 1 plate. 1500 w. Engr, Lond—Sept. 7, 1900. No. 36466 A.

Wide Firebox 10-Wheel Passenger Locomotive. Drawings and description of engines built for the D. L. & W. R. R., which are the heaviest passenger locomotives ever built. 900 w. Am Engr & R R Jour—Sept., 1900. No. 36282 C.

Rolling Stock.

New Rolling Stock for Express Trains of the Northern Railway of France (Le Nouveau Matériel à Bogies pour Trains

Rapides du Chemin de Fer du Nord). M. Defauconpret. A very detailed account of the new corridor bogie railway carriages of the Northern Railway of France. 18-000 w. 5 plates. Rev Gen des Chemins de Fer—July, 1900. No. 36644 H.

Ton-Mileage.

Ton-Mileage for Motive Power Statistics. C. H. Quereau. Discussing whether the tonnage of the engine should be included in the ton-mileage. 3000 w. R R Gaz—Aug. 31, 1900. No. 36182.

NEW PROJECTS.

Austria.

The Solution of the Tauernbahn Route (Zur Lösung der Tauernbahnfrage). A. Waldvogel. A discussion of the railway proposed to connect the Tyrol with Trieste, with maps and profiles of the various routes. Two articles. 10000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 17, 1900. No. 36621 each B.

China.

Railway Construction in French Indo-China. A review of various French projects in Indo-China and Southern China. 1100 w. Engng—Sept. 14, 1900. No. 36594 A.

The Building of the German Railway in Shan Tung (Der Bau der Deutschen Eisenbahn in Shantung). A general description from the *Zeitung der Verein Deutschen Eisenbahnverwaltungen* of the line of the railway which has been started inland from Kiauchow, China. 1000 w. Zeitschr f Klein u Strassenbahnen—Aug. 1, 1900. No. 36552 C.

Madagascar.

Ways of Communication and Means of Transport on Madagascar (Madagascar. Voies de Communications et Moyens de Transport). J. J. Marie. A report of a committee of the Société des Ingénieurs Civils de France, with critical comments by the *Moniteur Industriel*. Serial. 2 parts. 10000 w. Moniteur Industriel—June 9, 16, 1900. No. 36568 each E.

New Railroads.

Six Months of Railroad Building in 1900. Particulars in detail, by states and territories, of railroads building and sections completed. 2000 w. R R Gaz—Aug. 31, 1900. No. 36185.

PERMANENT WAY AND BUILDINGS.

Ballast.

On the Structure of Cementing Gravel. Geo. R. Wieland. Discusses the manner in which material such as cementing gravel, used as ballast, forms rocks. 900 w. Ry & Engng Rev—Sept. 15, 1900. No. 36428.

Curves.

Railway Transition Curves. F. K.

Vial. An analysis of the fundamental principles, simple demonstrations, and tables of deflections and co-ordinates. 6500 w. Eng News—Sept. 20, 1900. No. 36571.

Derailments.

Derailments. J. H. Wallace. A paper presented before the Pacific Coast Railway Club, discussing the causes of derailments on curves. 1500 w. Ry & Engng Rev—Sept. 15, 1900. No. 36427.

Ditching Machine.

Ditching Machine on the Chicago Great Western. An illustrated description of a ditcher car which has done good service. 1000 w. Ry & Engng Rev—Sept. 15, 1900. No. 36425.

Eastern Association.

Eastern Maintenance of Way Association Meeting. Abstracts of papers and reports of committees at the meeting at Saratoga. 1300 w. R R Gaz—Sept. 28, 1900. No. 36800.

Education.

Education of Railroad Men as Subordinates for the Maintenance of Way Service. Walter G. Berg. Abstract of paper before the Eastern Maintenance of Way Association, advocating the establishment of railroad trade schools at important centers. 1400 w. Eng News—Sept. 20, 1900. No. 36548.

Education of Railroad Men for Maintenance of Way. Walter G. Berg. Extracts from a paper before the Eastern Maintenance of Way Association, advocating the establishment of railroad trade schools and presenting an outline programme for such a school. 2500 w. R R Gaz—Sept. 21, 1900. No. 36576.

Galveston.

The Great Texas Hurricane. The effect of the storm upon the railways and shipping. The great dock enterprise of the Southern Pacific R. R. Co., which was wrecked. Illustrated. 1600 w. Ry Age—Sept. 14, 1900. No. 36478.

Japan.

Construction on the Kyoto Ry., Japan. Willard C. Tyler. A short illustrated description, showing construction of wooden false work lashed together with grass rope. 400 w. Ry & Engng Rev—Sept. 15, 1900. No. 36426.

Manchuria.

Russian Railway Construction in Manchuria (Die Russischen Eisenbahnbauten in der Mandschurei). F. Theiss. With map and views of construction work at various points along the line. 2500 w. Oesterr Monatschr f d Oeff Baudienst—Sept., 1900. No. 36650 D.

Paris.

The Works of the Western Orleans and

Metropolitan Railways in Paris (Die Bauten der Französischen Westbahn der Orleans-bahn, und der Stadtbahn in Paris). H. Koestler. A description of the improved terminal facilities recently constructed in Paris, and of the new underground road, with map. 3500 w. 1 plate. *Zeitschr d Oesterr Ing u Arch Ver*—Aug. 31, 1900. No. 36622 B.

Rails.

Rail Making Problems. Compares old and modern practice, and discusses many points of interest. 2500 w. *Ir & Coal Trds Rev*—Aug. 24, 1900. No. 36242 A.

Roundhouse.

A Remarkable Roundhouse—Chicago & Northwestern Railway. An illustrated description of a well equipped round house at Clinton, Ia. 900 w. *Ry Master Mech*—Sept., 1900. No. 36493.

Signals.

Automatic Block Signal Failures Due to Lightning. H. D. Miles. Read before the Ry. Sig. Club. A brief account of steps taken by the Michigan Central R. R. to overcome difficulties due to lightning. 1700 w. *Ry & Engng Rev*—Sept. 8, 1900. No. 36353.

New Interlocking Electric Switch and Signal System. J. R. Cravath. A well illustrated description of the Taylor system, which is entirely operated by electricity. 1600 w. *Elec Wld & Engr*—Sept. 15, 1900. No. 36397.

Pneumatic Signalling Plant at the Paris Exhibition. An illustrated description of the system and the exhibit of the International Pneumatic Railway Signalling Co., of Rochester, N. Y. 1500 w. *Engng*—Sept. 14, 1900. No. 36592 A.

Signals on the State Railways of Belgium (Les Signaux des Chemins de Fer de l'Etat Belge). M. Lavigne. Remarks on an accident, with an account of the signal system on Belgian railways and some French ones. 2000 w. *Moniteur Industriel*—May 19, 1900. No. 36565 E.

The Taylor Electric Switch and Signal Apparatus. A well illustrated account of this system, which is entirely electric. 2000 w. *R R Gaz*—Sept. 28, 1900. No. 36803.

Track Diagrams.

The Condition of Track on the New

York Central. P. H. Dudley's autographic records of the condition of the track of the New York Central for 1898 and 1899. 1 plate. 600 w. *R R Gaz*—Sept. 14, 1900. No. 36423.

Tunnels.

The Ventilation of Long Tunnels (Die Lüftung Langer Tunnels). A. Birk. An investigation of the use of fan ventilation for tunnels, with especial reference to the application of the Saccardo system at the St. Gothard tunnel. 4500 w. 1 plate. *Oesterr Monatschr f d Oeffent Baudienst*—Sept., 1900. No. 36661 D.

TRAFFIC.

Development.

The Development of Nations by Railways (Länder, Völker, und Eisenbahnen). H. Von Mühlenfels. A study of the influence of railways upon national development, a paper presented before the Railway Society at Berlin. Two articles. 6000 w. *Glaser's Annalen*—Aug. 15, Sept. 1, 1900. No. 36653 each D.

The Railways of the World (Die Eisenbahnen der Erde). Tabulated statistics of the development of the railways of the world from the close of 1894 to the end of 1898, in relation to population. 2000 w. *Stahl und Eisen*—Sept. 1, 1900. No. 36650 D.

Pooling.

The Pooling of Railway Freight Cars. J. R. Cavanagh, in the *Journal of Political Economy*. A discussion of the loss to railroads by the present system, and suggesting a plan that would greatly increase the revenue. 2200 w. *R R Car Jour*—Sept., 1900. No. 36380.

Switzerland.

Statistics of the Swiss Railways (Aus der Schweizerischen Eisenbahn-statistik). Tabulated data brought down to the close of 1898, with discussion. 2000 w. *Schweizerische Bauzeitung*—Aug. 11, 1900. No. 36664 B.

Trans-Siberian.

The Trans-Siberian Railroad. Report from Consul-General W. R. Holloway, St. Petersburg, containing an extract from the *Novoe Vremia*, giving fares and train service. 500 w. *U. S. Consular Reports*—Sept. 19, 1900. No. 36543.

STREET AND ELECTRIC TRAMWAYS

Berlin.

Electric Driving on the Berlin Municipal Railway (Der Elektrische Betrieb auf der Berliner Stadt- und Ring Bahn). A symposium of contributions from official inspectors and engineers in Berlin concerning the working of the road by electricity. 10000 w. *Glaser's Annalen*—Aug. 15, 1900. No. 36655 D.

Brazil.

The Sao Paulo Tramway, Light and Power Company. Illustrates and describes the plant of an important city of Southern Brazil. 3000 w. *St Ry Jour*—Sept. 1, 1900. No. 36278 D.

Car Equipments.

Deficiencies in Car Equipments. R. H.

Twedy. A criticism of American practice from an English point of view. 1500 w. *Elec Rev*, Lond—Aug. 24, 1900. No. 36232 A.

*Centrifugal Railway.

Coney Island's Centrifugal Railway. An illustrated description of railway in which a car, carrying passengers, runs around the inner circumference of a vertical circle. 400 w. *Sci Am*—Sept. 22, 1900. No. 36582.

Columbus, O.

Operating Methods of the Columbus Railway Company. Describes the methods and gives information of interest. 3000 w. *St Ry Jour*—Sept. 1, 1900. No. 36272 D.

Consolidation.

Street Railway Consolidation. Editorial on the advantages of consolidation in economic conditions. 2000 w. *St Ry Jour*—Sept. 1, 1900. No. 36277 D.

*Contact System.

A Simple Closed-Conduit Traction System. An illustrated description of a simple device for making contact between a feeder and sectional conductor as the car passes over the latter. 600 w. *Elec Rev*, N. Y.—Sept. 19, 1900. No. 36732.

The Dolter Surface Contact System for Tramways (Contact Superficiel pour Tramways, Système Dolter). A. Bainville. Detailed description of a system similar to the Diatto, now in operation in Paris. 1800 w. *Electricien*—Aug. 25, 1900. No. 36687 B.

*Conversion.

Preparing to Operate the Broadway Cable Road by Electricity. An illustrated account of rapid and extensive alterations of the track equipment of the Broadway line, without interrupting traffic. 500 w. *Elec Rev*, N. Y.—Sept. 19, 1900. No. 36730.

Convertible Car.

A Large Convertible Car. An illustrated description of a car seating forty-six persons, built by the J. G. Brill Co., for the New Castle (Pa.) Traction Co., open in summer, closed in winter. 1000 w. *St Ry Rev*—Sept. 15, 1900. No. 36515 C.

Electric Air-Brake.

A New Electric Air-Brake System. An illustrated description of a system of electrically controlled air-brakes, designed especially for electric cars. 1300 w. *Elec Rev*, N. Y.—Sept. 19, 1900. No. 36734.

Extension.

Extension of the Plant of the Worcester Consolidated Street Railway. The road is so advantageously placed that it practically controls the largest mileage in New England. Describes the enlargement of

the station and unique features to be introduced. 3500 w. *St Ry Jour*—Sept. 1, 1900. No. 36276 D.

Funicular.

The Funicular Railway of Montmartre at Paris (Le Funiculaire de Montmartre à Paris). J. Laverchère. An illustrated account of the inclined cable railway up Montmartre, in Paris. 2000 w. *Génie Civil*—Aug. 11, 1900. No. 36627 D.

Interurban.

A Forty-Mile Interurban Electric Railway. W. N. Zurfluh. Illustrated description of the power station and equipment of the Dayton, Springfield & Urbana (Ohio) Railway. 1500 w. *Am Elect'n*—Sept., 1900. No. 36268.

Locomotive.

Electric Locomotive for Main Railway Lines. Built by the Allgemeine Elektrizitäts-Gesellschaft (Elektrische Vollbahn-Lokomotive der A. E. G. auf der Pariser Weltausstellung). An illustrated description of a locomotive which can haul a 300-ton train at the rate of 30 kilometers an hour. 1800 w. *Zeitschr f Klein-u Strassenbahnen*—Aug. 1, 1900. No. 36551 C.

Main Railways.

Electric Traction on Main Railways. N. H. Heft. A portion of the report made to the International Tramway Congress at Paris in 1900, giving experience on the New York, New Haven & Hartford R. R. 6000 w. *St Ry Rev*—Sept. 15, 1900. No. 36518 C.

Monorail.

Manchester & Liverpool Railway: Brakes and Signals. F. J. Behr. A paper before the British Association, discussing braking and signalling on the proposed high-speed monorail line. 1400 w. *Elec Engr*, Lond—Sept. 14, 1900. No. 36744 A.

The Manchester and Liverpool Express Railway. Sir W. H. Preece. Paper before the British Association, giving a brief description of a proposed monorail line, with single-car trains having a speed of 110 miles an hour. 700 w. *Elec Rev*, Lond—Sept. 14, 1900. No. 36743 A.

New Jersey.

Important Work in Northern New Jersey. Illustrates and describes important extensions to the lines of the New Jersey & Hudson River Railway & Ferry Co., and of their equipment. 1500 w. *St Ry Jour*—Sept. 1, 1900. No. 36279 D.

Niagara Gorge.

The First Five Years' Experience in Maintaining the Niagara Gorge Railroad. George A. Ricker. An illustrated account of the construction of the road, and features of interest. 3000 w. *St Ry Jour*—Sept. 1, 1900. No. 36274 D.

Paris.

Street and Local Railways at the Paris Exposition (Die Strassen- und Kleinbahnen auf der Pariser Weltausstellung). Statistics of tramways in Paris, with an illustrated account of the new underground road. 1600 w. *Zeitschr f Klein-u Strassenbahnen*—Aug. 1, 1900. No. 36-550 C.

The Metropolitan Railway of Paris. Illustrated description of this road, its construction, equipment and operation. 5000 w. *St Ry Jour*—Sept. 1, 1900. No. 36-273 D.

The Paris Metropolitan Railway (Le Métropolitain de Paris). A review of the probable traffic and finances of this new underground road. 2000 w. *Moniteur Industriel*—Aug. 4, 1900. No. 36-841 E.

The Metropolitan Railway Company, of Paris (Compagnie du Chemin de Fer Métropolitain de Paris). The report of the administrative council, at the general meeting, on the road and its finances. 3000 w. *Moniteur Industriel*—July 28, 1900. No. 36838 E.

Pekin.

The Pekin Electric Tramway and Light and Power Station (Die Elektrische Bahn Pekin-Ma-Chia-pu und das Licht- und Kraftwerk Pekin). A. Fischer. With plan of the road and views of the power house. 2000 w. *Zeitschr d Ver Deutscher Ing*—Sept. 1, 1900. No. 36608 D.

Polyphase Traction.

Polyphase Electric Traction. Prof. C. A. Carus-Wilson. Abstract of a paper before the Institution of Mechanical Engineers, giving an illustrated account of the Burgdorf-Thun railway, in Switzerland. 7000 w. *St Ry Rev*—Sept. 15, 1900. No. 36514 C.

Portland.

The Street Railways of Portland, Me., and Vicinity. C. B. Fairchild. An illustrated general description of the system of the Portland Railroad Co. and the suburban line of the Portland & Yarmouth Electric Railway Co. 9000 w. *St Ry Rev*—Sept. 15, 1900. No. 36513 C.

Pressure.

What Pressure Is Dangerous on Electric Railways with Overhead Trolley Wires. William Rung. Translated from the Danish *Civilingenieur*. Gives results of experimental investigations, showing that all pressures between 100 and 1,000 volts must be regarded as equally dangerous, and as the higher pressures lead to greater economy there is no reason for not using them. 1700 w. *Nature*—Aug. 23, 1900. No. 36226 A.

Rails.

Recent Tramway Construction, with Special Reference to the Demerbe System. Wm. Dawson. Paper before the British Association, giving an illustrated description of the Demerbe trough-type rail and data concerning its satisfactory performance in Bradford. 2400 w. *Elec Engr*, Lond—Sept. 14, 1900. No. 36741 A.

The Wear of Rails and the Value of Welded Joints (Schienenverschleiss und die Oekonomische Bedeutung des Verschweissten Schienenstosses bei Strassenbahnen). K. Beyer. Discussing the wear of tramway rails, with especial reference to the impact on rail-ends at joints. 2000 w. *Schweizerische Bauzeitung*—Aug. 18, 1900. No. 36665 B.

Seneca Lake.

Elmira & Seneca Lake Ry. An illustrated description of a road in Chemung and Schuyler Counties, New York. 2200 w. *St. Ry Rev*—Sept. 15, 1900. No. 36-516 C.

Spliced Cars.

Spliced Cars at Rochester, N. Y. An illustrated account of the method of cutting cars in two and lengthening them 9 feet. *St Ry Rev*—Sept. 15, 1900. No. 36519 C.

Sunderland.

Sunderland Corporation Electric Tramways. Illustrated description of the commencement of what will ultimately be an extensive system of municipal electric tramways. The line opened is 12.5 miles in length. 2000 w. *W. Elect'n*, Lond—Aug. 24, 1900. No. 36230 A.

Tri-Phase.

The Tri-Phase Electric Cable Road on Mont Dore, France (Die mit Dreiphasen-Strom Elektrisch Betriebene Seilbahn auf den Mont-Dore in Frankreich). E. A. Ziffer. A paper describing this cable road, said to be the only one in Europe worked by tri-phase currents. 2500 w. *Mitt d Ver f d Förd d Local-u Strassenbahnwesens*—July, 1900. No. 36554 D.

Wagon Tracks.

Wagon Tracks in Silesia (Strassen-gleise in Schlesien). H. Pusch. An article from the *Centralblatt für Bauverwaltg*, describing steel tracks for wagons laid down in a Silesian village street. 1000 w. *Mitt d Ver f d Förd d Local-u Strassenbahnwesens*—July, 1900. No. 36-555 D.

Wichita, Kan.

The Early Wichita Electric Railway, Built in 1887. T. C. Hughes. Brief illustrated description of interesting details of this enterprise. 900 w. *St Ry Jour*—Sept. 1, 1900. No. 36275 D.



VOL. XX.

DECEMBER, 1900.

No. 3.

THE INDUSTRIAL SIGNIFICANCE OF THE ANGLO-GERMAN ALLIANCE.

An Editorial Review.

THE future of China may be said to be practically settled by the Anglo-German agreement—insomuch the more because this pact repeats and enforces the principles already declared by the United States Government. And this triune agreement between the three great manufacturing nations of the earth marks an event of supreme importance to men of foresight who are concerned with industrial development. Latest in time, broadest in possibility, this event is also furthest advanced in the evolution of economics and politics—the first great recognition of the newly-conceived attitude of the strong nations toward the weak one. For we begin to see now that this is the epoch of beneficence in dealing with alien races—that the material interests of a strong nation are best served by living up to the noble ideals so eloquently presented in these pages two years ago by Captain Mahan:

"Ideas underlie action," he wrote. "If the paramount idea of beneficence becomes a national conviction, we may stumble and err, we may at times sin, or be betrayed by unworthy representatives; but we shall advance unflinchingly.

"We have the two great examples. Great Britain has been, in the main, and increasingly, beneficent and strong. Spain from the very first, as the records show, was inhumanly oppressive to the inferior races; and, after her own descendants in the colonies became aliens in habit to the home country, she to them also became tyrannically exacting. But, still more, Spain became weaker and weaker as the years passed, the tyranny of her extortions being

Copyright, 1900, by John R. Dunlap.

partially due to exigencies of her political weakness and to her economical declension. Let us, however, not fail to observe that the beneficence, as well as the strength, of Great Britain has been a matter of growth. She was not always what she now is to the alien subject.

"The writer believes firmly in the ultimate power of ideas. Napoleon is reported to have said: 'Imagination rules the world.' If this be generally so, how much more the true imaginations which are worthy to be called ideas! There is a nobility in man which welcomes the appeal to beneficence. May it find its way quickly now to the heads and hearts of the American people, before less worthy ambitions fill them; and, above all, to the kings of men, in thought and in action, under whose leadership the land makes its giant strides.

"Materially, the interest of the nation is one with its beneficence; but, if the ideas get inverted, and the nation sees in its new responsibilities, first of all, markets and profits, with incidental resultant benefit to the natives, it will go wrong. Through such mistakes Great Britain passed. She lost the United States; she suffered bitter anguish in India; but India and Egypt testify to-day to the nobility of her repentance. Spain repented not. The examples are before us. Which shall we follow?" *

The bitter schooling which England has had in South Africa, and the sorry blunders of the United States in the Philippines have taught the Great Powers, as was pointed out in an editorial in these pages last September, that the difficulties of world politics are made greater, not less, by the assumption of "the enormous load of the actual direction of the affairs" of huge sections of the race in semi-civilised lands; that the true course is "the inspiring, advising, and to a large degree the organising of a new and wisely-progressive government which, to the greatest extent possible, should be permitted and led to work out its own order. * * * This, and not the stupendous attempt to raise the mass by outside agency, should be the end to which the best efforts of Europe and America should be directed."† The political jingoes have had a warning which they can never again forget nor ignore. The strength of the "anti-imperialist" movement in the United States has made the handwriting on the wall plain enough there. And Great Britain, as the Hon. John Barrett recently wrote, "is now face-to-face with a growing sentiment against any further extension of her imperial domain, and has always led the agitation in favour of the open door. If the war in South Africa would seem to be inspired by a sentiment contradictory to this assertion, it, on the other hand, would appear to mark the limit of conquest which the English people would favour or permit."

* The Relations of the United States to their New Dependencies. THE ENGINEERING MAGAZINE, January, 1899, page 521.

† THE ENGINEERING MAGAZINE, September, 1900, page 802.

In short, the fearful cost of territorial acquisition in Africa and Oceanica has taught physically the lessons which the Hague Conference put morally and intellectually. The world has gained, from the sufferers by the Boer war and Spanish wars, the knowledge it rejected when formulated in the abstract by the peace commissioners. War and conquest do not pay. The appreciation of the fact is more vivid than ever it was before, and out of the turmoil of the close of the nineteenth century has come a firm and stable adjustment of ideals which holds high promise for the unbroken peace and growing industry of the twentieth. Russia, long regarded as the menace to European diplomacy, under the young Czar shows unmistakeable aspirations for peace and industrial development. The German Emperor has changed the rôle of war lord for that of the promoter of enterprise and the foster-father of commerce. What the preachers of peace could not impress upon the nations, the precipitators of war have written in blood and fire, and the lesson is learned.

The strong and direct sign of the change is the subsidence of the clamour for the partition of China and the generally-accordant working of the Powers for a common end—the restoration of order, the maintenance of the entity of the empire, the establishment of a secure internal government, and the opening of common opportunity for development of the country and for commerce with it. The event has justified our forecast of July—that “Europe and America will come to an agreement by which at least nominal autonomy for China will be preserved.”* The agreement is as truly Anglo-American as if Mr. Chamberlain’s suggestion had been formally fulfilled:

“I would go so far as to say that, terrible as war may be, even war itself would be cheaply purchased if in a great and noble cause the Stars and Stripes and the Union Jack should wave together over an Anglo-Saxon alliance. (Prolonged cheers.)

“The recent collapse of China has opened up one of the greatest questions of our time. Is this vast country, with untold mineral and other resources, and with a population of four hundred millions of frugal, industrious people, to be partitioned among European nations? Is the greatest potential market of the world to be permanently closed to general trade, or is it to remain open, with its incalculable possibilities, to all nations on equal terms? The interest of the United States in the decision is the same as that of Great Britain. If it should ever be necessary to enter into negotiations, in order to secure to all the world an equal opportunity in regard to this commerce, it cannot be doubted that they would be definitely more influential if backed by the joint action of the United States and Great Britain, than if either of these Powers held aloof.”

* Editorial in THE ENGINEERING MAGAZINE, July, 1900, page 584.

The Anglo-German agreement is an actual instrument; the participation of the United States is one of unity of aim and sympathy as complete as any written bond could make it. Compare the declaration of Secretary Hay, quoted in these pages last August, with the text of the Anglo-German compact given out by the British Foreign Office on October 31:

"(1.) It is a matter of joint and permanent international interest that the ports on the rivers and littoral of China should remain free and open to trade, and to every other legitimate form of economic activity for the peoples of all countries without distinction, and the two Governments agree on their part to uphold the same for all Chinese territory so far as they can exercise influence.

"(2.) Her Britannic Majesty's Government and the imperial German Government will not on their part make use of the present complication to obtain for themselves any territorial advantages in Chinese dominions, and will direct their policy toward maintaining undiminished the territorial condition of the Chinese Empire.

"(3.) In case of another Power making use of the complications in China in order to obtain, under any form whatever, such territorial advantages, the two contracting parties reserve to themselves the right to come to a preliminary understanding as to the eventual steps to be taken for the protection of their own interests in China."

"The purpose of the President is, as it has been heretofore, to act concurrently with the other Powers, first, in opening up communication with Peking and rescuing the American officials, missionaries, and other Americans who are in danger; secondly, in affording all possible protection everywhere in China to American life and property; thirdly, in guarding and protecting all legitimate American interests; and fourthly, in aiding to prevent a spread of the disorders to the other provinces of the empire and recurrence of such disasters.

"It is, of course, too early to forecast the means of attaining this last result, but the policy of the Government of the United States is to seek a solution which may bring about permanent safety and peace in China, preserve Chinese territorial and administrative entity, protect all rights guaranteed to friendly Powers by treaty and in law, and safeguard for the world the principle of equal and impartial trade with all parts of the Chinese Empire."

This is the policy which has been advocated by the body of well-informed authorities and industrial leaders who have discussed the question in these pages during recent years. It was first indicated by Messrs. J. S. Fearon and E. P. Allen, when they pointed out that America should ally herself with England in the interest of maintaining the central authority in China and the open door.* Minister Denby formulated it still more definitely, showing that England and

* The Chinese, and Recent Industrial Progress in China. November, 1898, page 165.

Germany recognise China as "the greatest market on earth for their manufactured goods, and the greatest field for industrial enterprise. They have no interest in dividing her up into hostile camps, in checking production, and paralysing progress. * * * It is the interest of the world to preserve the autonomy of China. It is particularly to American interest to do so."* And no single nation could effectively secure this end. The fact is, as we pointed out editorially in October, 1899, that "the newly-opened places of the world need, for their development, the federated effort of all the great nations." But perhaps the clearest voice of all was that of Hon. John Barrett.

"If America, England and Germany will exert in unison the influence which each individually possesses, there will be no question as to the success of their policy. Once seeing that these three powers are in earnest, Russia and France will be compelled to join them."†

"America's supreme concern in China, which appeals to the greatest number of her people, is the commercial opportunity. That is likewise Great Britain's chief concern, and should be that of Germany, France and Japan. * * * Looking candidly into the future, the United States will therefore endeavor, whether in co-operation with Great Britain and other nations or not, to preserve the integrity of the Chinese Empire and prepare the way for a legitimate, untrammelled, material exploitation of China's vast resources."‡

So said Mr. John Foord in his article on "China in Regeneration" in these pages in August last: "Great Britain, the United States, and Japan can be confidently reckoned on to stand for the maintenance of equality of commercial opportunity throughout the Chinese Empire, and consequently to stand for the preservation of its integrity." So said Gen. Wm. Barclay Parsons, in the interview recorded in our editorial pages last July. The event affords a striking instance of the heed which the statesman of to-day has learned to pay to the productive, constructive, and commercial interests of the country—of the influence which the engineer, works manager, and the industrial leader may exercise, and *must* exercise, in so-called "affairs of state." For the modern state lives by and in its industries.

The action of the three great powers in the East is thus a clear acknowledgment that the leaders of thought and action see their fundamental interests to be identical. The great commercial rivals appear as political allies. Antagonism wanes as emulation waxes. The theorem that one nation's ruin is another's gain has gone into the

* THE ENGINEERING MAGAZINE, December, 1898, page 347.

† England, America, and Germany as Allies for the Open Door. THE ENGINEERING MAGAZINE, September, October, 1899.

‡ The Crisis in China; Its Meaning for an Engineering Constituency. THE ENGINEERING MAGAZINE, September, 1900.

scrap-heap, with other dead dogmas of political economy. Equality of opportunity—rivalry in adaptation to it, is the newer ideal. England is urging the world to acceptance of her far-sighted and consistent support of the open door, at home and abroad. Germany and the United States recognise its wisdom at the long focus of the East; their eyes are not yet adjusted to see at the short range of home affairs, but the vision is gradually growing more distinct, and it may be forecast even now that the time is not far off when they, too, will acknowledge and accept the clear-eyed statesmanship of Cobden and Bright.

With the vast resources of the United States relieved from the menace of involvement in business upheaval and freed for the service of peaceful industrial development throughout the world; with the forces of Europe and America no longer engrossed in the jealousy of international struggle for extended political boundaries, but, by the great precedent of the Chinese settlement, united in keeping peace and order and maintaining, instead of remaking, the map of the East; with the marvellous increase in productive capacity of the last fifty years to build upon—the twentieth century opens with matchless promise for the productive forces of the earth and for those who “direct them for the use and benefit of man.”

The hero of the future is the captain of industry, not the captain of armies. The struggle is to produce the most, and most cheaply—not to destroy the most and the most quickly. The strong nation is the one whose manufactures and whose merchant marine reach farthest in supplying the wants of the peoples, and return best laden with the needed goods of other lands. The keynote of success, the secret of power, is economy—economy in production, in methods, in management. The vast growth of manufacturing establishments must be met by adequate growth and adjustment in administration. Organisation must replace the individual supervision and control which was adequate even to the great works of a half century ago. In the study of works management lies the highway to larger success and wider influence than the material conditions of the past ever made possible. Before engineers and managers lies the duty of meeting the conditions—and the other great duty of using their influence and their power in the affairs of the nation, so that justice and wisdom may govern the state at home and abroad. The task is a responsible one, but home and foreign politics have proved, during the year just closing, the triumphant success which follows when the industry and commerce of the country speak clearly to its rulers.

WATER-TUBE STEAM GENERATORS FOR NAVAL SERVICE.

By B. H. Thwaite.

HAVING considered the comparative merits and disadvantages of the shell and water-tube type of steam generator, and their respective adaptability to the requirements of naval service, it remains to consider the chief representatives. Hardly a month passes without the addition of a new design to the many already on the market. Only the typical and basal forms can be considered.

In the large-tube class those selected are the Belleville and Babcock & Wilcox; the Niclausse and Dürr may be considered combinations of large- and small-tube construction; the small-tube type is represented by the Du Temple, Thornycroft, Yarrow, and Normand.

All water-tube boilers have certain broad characteristics:

1:—The firegrate placed immediately over a nest or group of large- or small-bore generator tubes.

2:—The generator tubes, fixed at varying angles of inclination and connected to each other in distinctive ways by means of collector boxes or headers.

3:—The water-and-steam drum in which the water level is maintained and into which the generator tubes pour their water and steam; various devices are provided in the drum to separate the steam and water, so that the steam can escape in a dry condition.

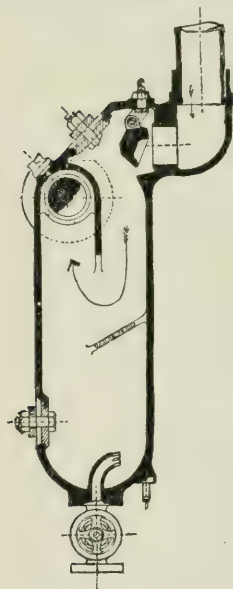
The Belleville Boiler. Anyone who has had to perform the difficult work of pioneering a new engineering departure—and especially a marine one—will realise in some measure the debt that progressive engineers owe to Mr. Belleville; to him is due the honour of having brought the large-water-tube boiler into the field of marine use.

The departure from the beaten track he indicated has been followed by far-reaching results, and his invention has been expanded in a remarkable manner, not only by the French marine but in foreign ones also. It may be also mentioned as a coincidence in favour of the progressive character of French practical science that we owe the remarkable innovation, the small-water-tube boiler, to a French officer, Commandant Du Temple; all the other designs of this small-tube type are based more or less on Du Temple's invention.

Mr. Thwaite's first article appeared in *THE ENGINEERING MAGAZINE* for November, 1900. The editors regret that space conditions absolutely prevent inclusion of Mr. Thwaite's excellent argument for homogeneity of steel for use in small water tubes, or his interesting section on automatic feed-water devices.

It is only just to the United States to mention that to its fertile soil of invention we owe the production of the most widely applied large-tube boiler for stationary purposes—the Babcock & Wilcox—besides that of the ingenious inventor Root.

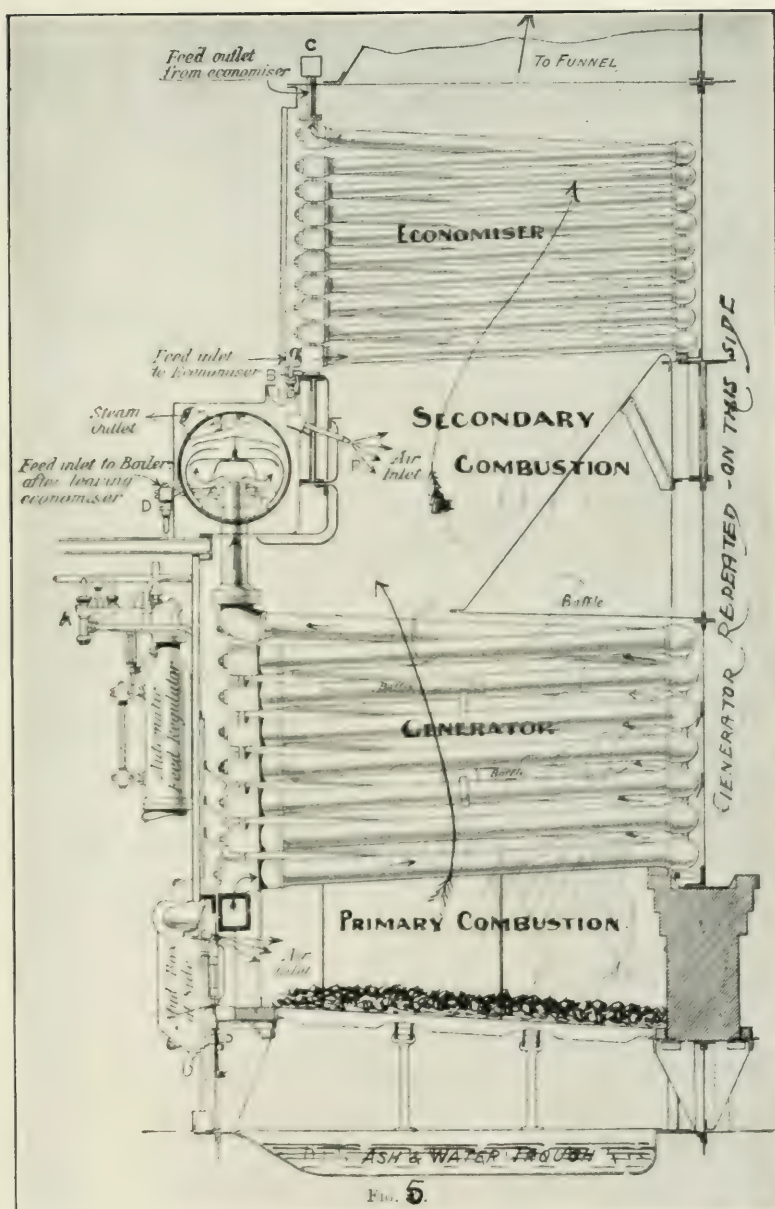
In the most advanced or “economiser” type of Belleville boiler* the generating tubes are only slightly inclined from the horizontal ($2\frac{1}{2}^{\circ}$); the tubes are of solid drawn steel. Twenty of these tubes (say 7 feet 6 inches long) complete a tube group, technically defined as an element. The ends of the tubes screw into malleable-iron collector boxes. The tubes constituting an element provide for a continuous passage from bottom to top for water and steam. Each tube group or element is connected at its lower end to a water chamber, and the top of each element is connected to the steam-and-water drum, this connection in every instance being located on the front end. In order to prevent the direction of the water currents from being disturbed by the rolling or pitching of the vessel, Mr. Belleville has invented an ingenious contrivance so located that all the water must flow through it before it can enter the lower water chamber; it acts also as a sediment collector.



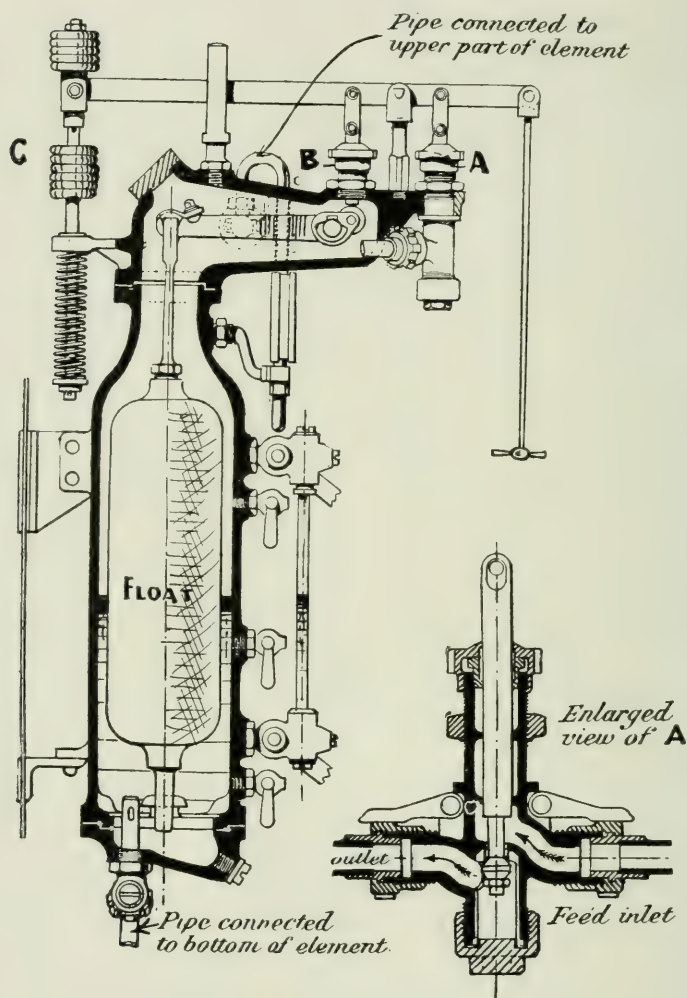
SEDIMENT COLLECTOR.
BELLEVILLE BOILER.

In the Belleville boiler the feed water is introduced, at a higher pressure than that of the steam, at the centre of the upper drum collector by means of a small non-return valve. It descends to the bottom of the collector and flows to the return water pipes. The introduction of the feed water naturally lowers the temperature of the water in the collector, and it is obviously inadvisable that it should be allowed to enter any of the tube groups or elements; to prevent this the tops of the latter are projected at least 8 inches above the bottom or invert of the drum collector. During the flow of water along the return pipes its temperature is gradually raised to a critical point, at

* The following table approximately represents the application of the Belleville boiler in terms of indicated horse power: France, built, 230,000, building, 145,300; Russia, built, 61,000, building, 197,000; Italy, building, 46,000; Germany, built, 10,000; Austria, built, 34,000, building, 24,000; Japan, built, 36,000, building, 50,000. In the list, 44 vessels are included of considerably over 10,000 indicated horse power each. The indicated horse power supplied to the British navy probably exceeds 150,000. It is stated that 41 millions sterling are embarked in British warships, already or in the course of being equipped with Belleville boilers.



STRUCTURAL ARRANGEMENT OF ECONOMISER TYPE BELLEVILLE BOILER.
The arrows show the cycle of circulation.



THE BELLEVILLE AUTOMATIC FEED REGULATOR.

The rise or fall of the float acts upon the system of levers through the stuffing-box at B to permit the weights at C to open or close the valve A. When the water level falls the valve is opened, and when the valve closes the excess water is returned to the feed tank. The whole is attached to the column leading to the feed collector.

which it cannot hold either the lime or magnesian salts in solution; by the time it has reached the sediment collector, when the deposition or precipitation actually culminates, the grease and salt contents are deposited in a more or less non-adherent form. In order to accelerate the deposition of the grease or lubricants that may be present in the feed water a simple system of induced precipitation is employed.

The precautionary separating arrangements described are effective for meeting the evils following the introduction of a certain proportion of sea water owing to defective tubular surface condensers, but under these conditions extra surveillance is necessary. If the condensers were properly designed and constructed sea-water leakage should never occur; it is expected that the general adoption of the water-tube boiler will bring about the much-desired improvement in tubular-surface-condenser design.

With all water-tube boilers, the maintenance of a steady water level is very desirable, if not imperative: Mr. Belleville has recognised this and has equipped his boiler with an automatic feed-water device intended to deliver the feed water in such proportions as to maintain as nearly as practicable a constant hydraulic level. The steam and water ejected from the different elements into the drum collector are there separated, but in order to produce perfectly dry steam Mr. Belleville with considerable ingenuity provides an arrangement of baffle plates.

Actual results have repeatedly proved the low heat-utilisation efficiency of the old or non-economiser type of Belleville boiler when using fuel containing hydrocarbons and under conditions of forced draft. This fact has been recognised by the inventor, and the economiser type has been designed to increase the heat-utilisation efficiency and to a certain extent has effected this object. This type has been applied to the latest-built British warships, including the sister ships *Powerful* and *Terrible*, both having a Belleville equipment intended to develop 25,000 indicated horse power.

It will be seen in the figure (page 333) that a nest of economiser pipes is superposed some five feet over the ordinary generator, the dimension representing the height of a second combustion chamber which is fed with powerful jets of air, so that the unoxidised gases ascending from the grate are burnt, part of the resultant heat being absorbed by the nest of economiser pipes and heating the feed water flowing through them. The economiser elements are accessible for cleaning purposes; their pipes are smaller than those of the generator. The modifications in the feed-water arrangements involved by the introduction of the economiser are simple. In the tables of evaporation, given further on, the improvements in evaporative effect resulting from the addition of the economiser are defined.

The evolution of the Belleville generator has involved the introduction of important accessory equipments which have added considerably to its complication, and the necessity of the highest character of

workmanship and material is obvious. Before referring to the more salient defects that have been recorded by the British Admiralty as being associated with the Belleville boiler, the obvious truism must be repeated that an invention, however excellent, may be ruined by bad structural arrangements, materials and workmanship. One wonders whether foreign navies have had the same unenviable experience that has fallen to the lot of the British Admiralty.* It is only scant justice to M. Belleville to point out that much of the prejudice against his generator was the result of the employment, in the early examples applied to the British navy, of simply welded instead of solid cold-drawn tubes. The salient defects of the Belleville boiler are:

1:—The use of welded tubes.

2:—The constructional arrangements for supporting the rear or back-end joints of the tubes are defective; contractive effects, following those of expansion, have resulted in the tubes leaving the rear-joint connecting boxes, which should be arranged so that they should have free play for expansion and also be well protected from flame effect.

3:—The line of direction for the circulation is broken too abruptly by the rear connection.

4:—The front conical connection with the collector is imperfect; the tendency of the associated tubes when expanding will be to prise open the conical joint.

5:—The angle of inclination of the tubes too nearly approaches the horizontal, and this tends to induce incrustation.

6:—The very elaborate arrangements for preventing lime, magnesia and grease from entering the tubes, prove that in this boiler reliance for clearance of these deposits cannot be placed upon the circulation effects. This defect would be lessened if the water circulation was more rapid; however, the internal galvanising of the tubes will greatly retard this destructive influence.

7:—Neither the fire doors or the smoke-box doors are made with sufficient care and rigidity to remain tight fitting when subject to rather violent alterations of temperature. The leaking smoke-box door will always prove prejudicial to the character of combustion; the smallest fractures allowing air to enter into chimney or funnel flue will seriously reduce its aspiration efficiency; further, the fire doors and

* The French cruiser *Guichen*, equipped with Belleville boilers, maintained an average speed of 16 knots in her recent trip from Brest to Saigon. On the other side, *The Engineer*, London, July 6, 1900, states that the British ship *Highflyer* broke down ignominiously; the *Diadem* had a disastrous voyage; the *Skate* torpedo boat was very nearly lost on her voyage to the Mediterranean; all these war-ships (British) had Belleville boilers.



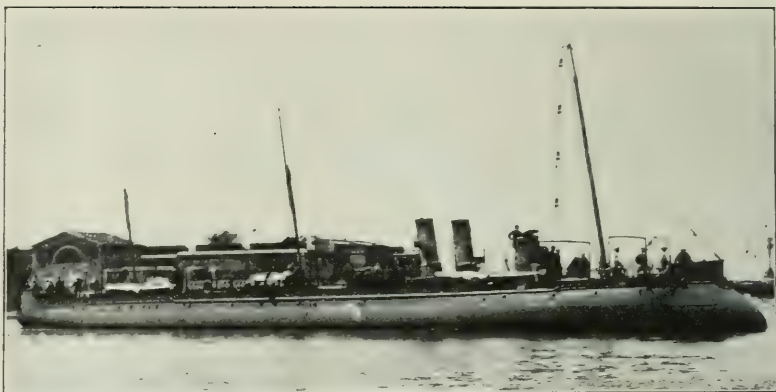
H. M. S. POWERFUL, STEAMING 18 KNOTS; BELLEVILLE BOILERS.

ash-pit doors should be so contrived that even if accidentally partly open they will automatically close in the event of a tube bursting.

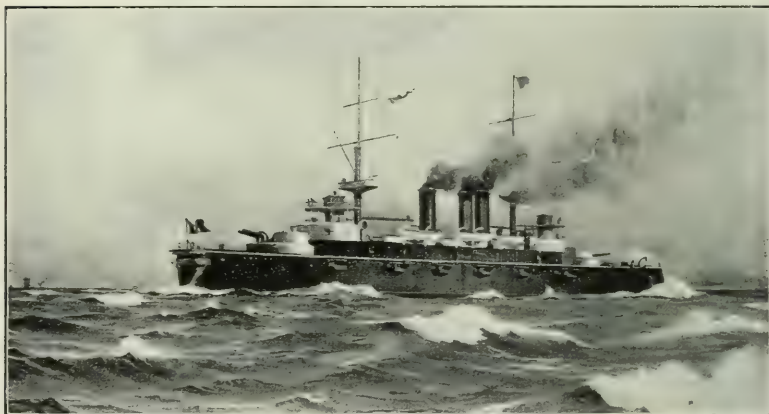
8:—Delicacy of accessory machinery. The Belleville feed regulator is most ingeniously contrived, but whether its structural character is suitable for everyday wear on board ship is at least questionable. All the spindles and actuating gearing of feed regulator and non-return valve should be formed of unoxidisable metal.



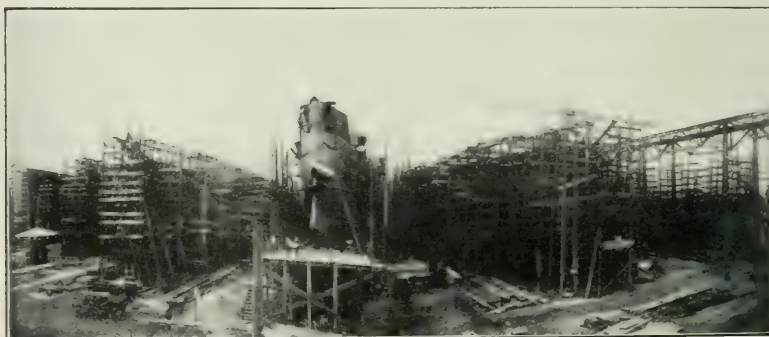
FRENCH BATTLE-SHIP MARCEAU, NICLAUSSE BOILERS OF 12,000 INDICATED HORSE POWER.



FRENCH TORPEDO BOAT TÊMÉRAIRE, EQUIPPED WITH NICLAUSSE BOILERS, WHICH UNDERWENT A MOST SATISFACTORY 10-HOURS' TEST.



ARMoured BATTLE-SHIP REGINA MARGHERITA, OF THE ITALIAN NAVY. 19,200 INDICATED HORSE POWER, NICLAUSSE BOILERS.



RUSSIAN CRUISER VARIAG, RECENTLY COMPLETED AT CRAMPS', 20,000 INDICATED HORSE POWER, NICLAUSSE WATER-TUBE BOILERS.

It is reported that her very successful trials have led the Russian Government to place orders for five more war-ships with American builders.



H. M. S. SEA GULL, FITTED WITH NICLAUSSE BOILERS

9:—Combustion arrangements. The space provided for primary combustion is inadequate, and until this serious defect is remedied the Belleville boiler will never be satisfactorily efficient in its heat utilisation, and will be unfitted for even a moderate degree of forced draft. The space provided for secondary combustion is satisfactory, but the method of introducing secondary air should give better distribution.*

* Abstracts from British Admiralty list of Belleville-boiler defects and proposed remedies.

Defects.

1. Burstings and overheating of tubes occurred in the Powerful, Terrible, Arrogant, Furious, and Hermes. Stated causes

Precautions.

The use of the highest character solid-drawn tubes.



CRUISER FRIANT, OF THE FRENCH NAVY, ON WHICH SEVERE TESTS OF THE NICLAUSSE BOILER WERE CARRIED OUT WITH MOST SATISFACTORY RESULTS.

The Niclausse Boiler. M. Niclausse has deviated from the ordinary track in his design—indeed, the Niclausse form may not be inaptly termed a combination of the small- and large-tube type, because by his duplex concentric-tube arrangement he secures to a considerable extent the erosive and scouring effect of rapid circulation—the conspicuous and valuable feature of the small-water-tube boiler. Ni-

various, most important being defects in manufacture of solid-drawn tubes and the accidental incursion of sea water.

2. Pitting of tubes. Occurred to a considerable extent in the *Diadem*; cause, acidity of water.

3. Nickel washers leaking; this was the cause of very numerous leakages; cause, burning away of rear or back-end tube connections.

4. Over-heating of tubes through imperfect circulation.

5. Leakage of door joints, especially reported in the case of the *Argonaut*; cause, doors not being interchangeable; unsuitable asbestos washers employed.

6. Smoke-box doors leaking.

7. Back-end tube supports burning away occurred in some cases; cause, defective brick-work.

8. Leaky safety valves frequent source of trouble; cause, the cutting of the valve seats by the scale blown out of the drum-collector baffle plates, which are very liable to oxidation.

Galvanising the tubes internally and the use of zinc rods; acidity of water to be neutralised by introduction of lime.

None suggested.

None suggested.

Better quality of asbestos washers.

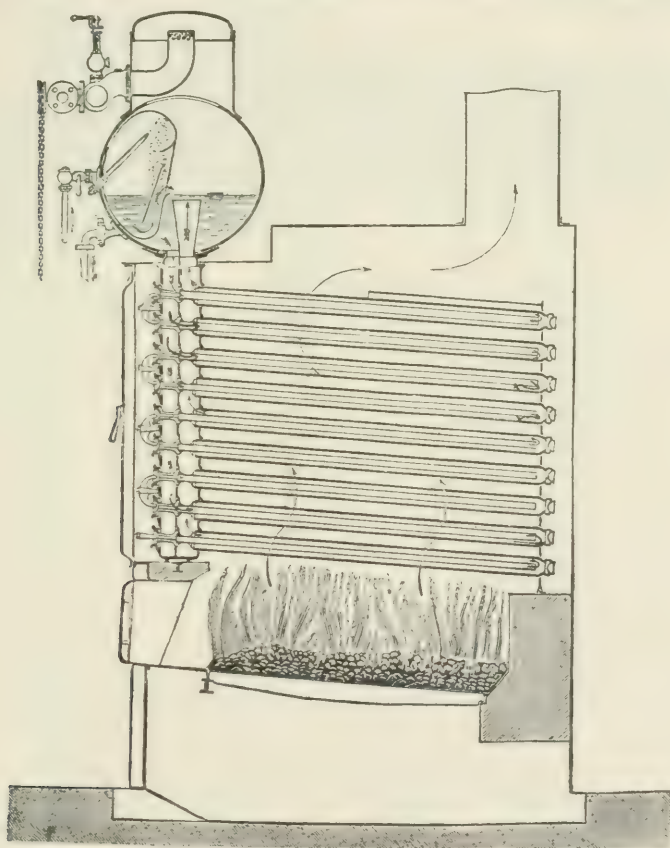
Better and stiffer construction and smaller dimensions.

Better brick-work.

Galvanising of the baffle plates of the drum collector.

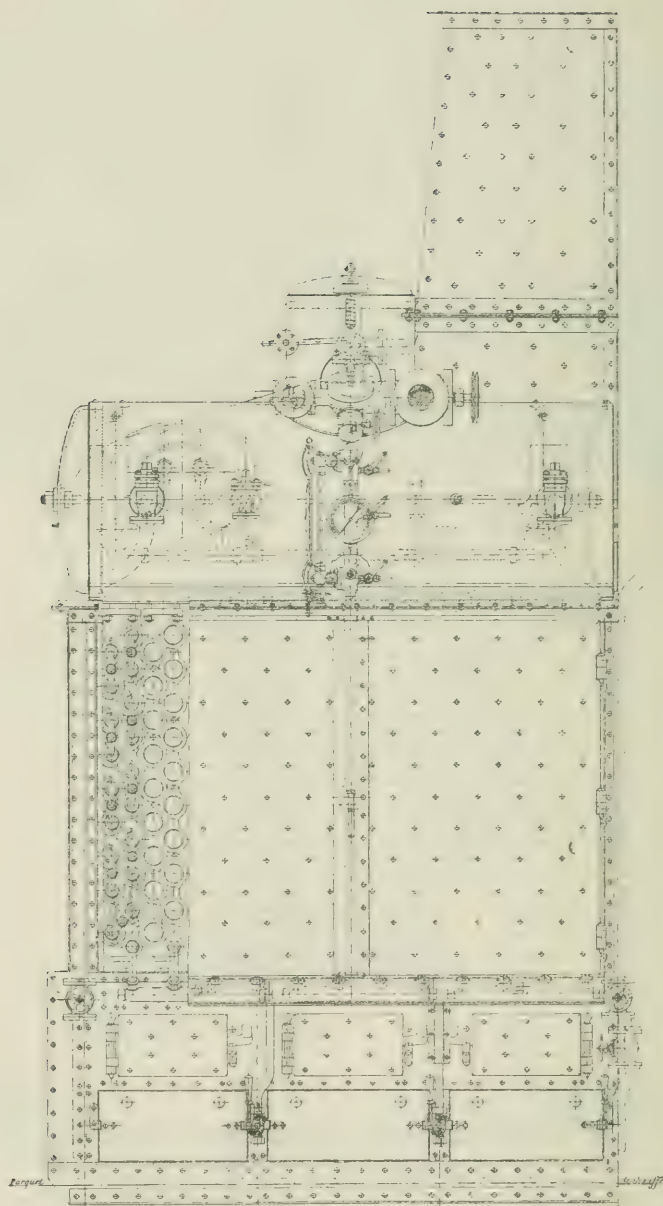
clausse has also adopted a steeper angle for his generator tubes, and he provides a rather larger cubic capacity for combustion over his grates; but in my opinion this might be greatly increased.

The figures, pp. 341-342, show the structural characteristics of this generator. It will be noticed that through the axis centre of the ordinary large inclined generator tube there is set another, and of course smaller, tube; the two concentric tubes are so connected to the front end that the cold feed water is introduced into this central tube, flows to the rear end, and then returns through the annular space formed between the two tubes. A partition in the front distributing box or



NICLAUSSE WATER-TUBE BOILER.

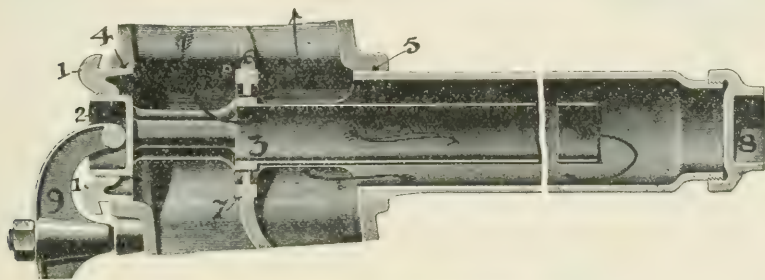
header effectually separates the introduced and down-flowing cold feed water from mixing with the hot water and steam. Page 342 shows the disposition of two groups of elements; it will be noticed that the



DISPOSITION OF TWO NICLAUSSE GROUPS OR ELEMENTS.

tubes are in direct vertical relationship with one another from top to bottom, each vertical group having its header chamber which is connected to the drum collector; this drum is provided with a diaphragm for separating the descending feed-water currents from the ascending ones of hot water and steam.

The method adopted by M. Niclausse for attaching the concentric tubes to their headers is in the highest degree ingenious, simple, and unique, and gives this generator a valuable advantage in comparison with certain others. This system of tube attachment, clearly shewn



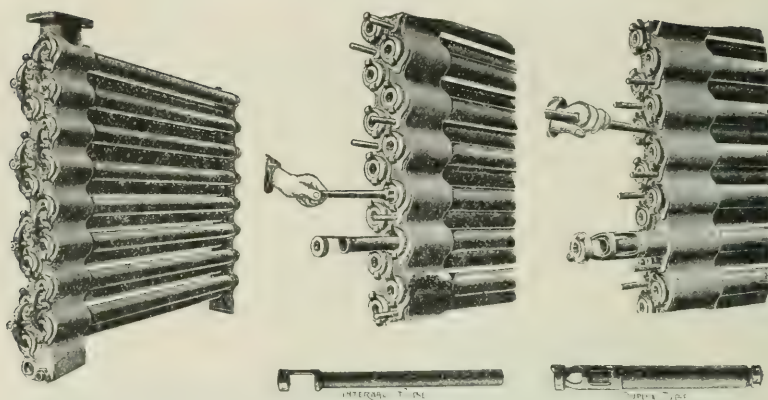
THE NICLAUSSE DUPLEX-TUBE SYSTEM

The front end of the tube is formed into a taper sleeve which can be forced tightly into the header, and is cut away to allow the free passage of the water. The front part of the inside sleeve of the inner tube is screwed into the sleeve of the outside tube and closes its front end so that the two tubes can be withdrawn either together or separately. The water flows down the inner tube and returns back through the annular space between the tubes together with the generated steam.

The tubes being held at one end only, are entirely free from expansion and contraction strains.

above, consists in the use of conical terminals and surfaces fitting coned apertures provided in the headers, the pressure necessary to maintain contact of the cone surfaces being secured by externally placed dogs. Although the Niclausse type of boiler has been extensively applied to marine work, the conical joints have been remarkably successful. The conspicuous feature of this duplex-cone arrangement is the rapidity with which it permits the replacing of a suspected tube.

The time occupied to effect the change of a tube when the generator is cold is one of a few minutes. This fact has been repeatedly demonstrated in the French navy, on the cruisers *Téméraire*, *Fleurus*, and *Friant*, as well as on the British naval vessel *Sea Gull*, on which a boiler working under full steam was isolated, its fires drawn, the water run off, the tube drawn and replaced ready for steam raising in 25 minutes. During a naval engagement this advantage of rapid tube renewal would be valuable beyond measure. The tubes all being interchangeable, the lower tubes, which are next to the grate and con-



SHOWING RESPECTIVELY A TUBE ELEMENT COMPLETE, REMOVAL OF AN INTERNAL TUBE, AND REMOVAL OF A COMPLETE DUPLEX TUBE.

sequently subjected to the greatest stress, can be replaced with the upper tubes, to great economic advantage. In the event of the fracture of a tube the sectional arrangement of grouping the tubes reduces the amount of steam and water ejected into the stoke hole.

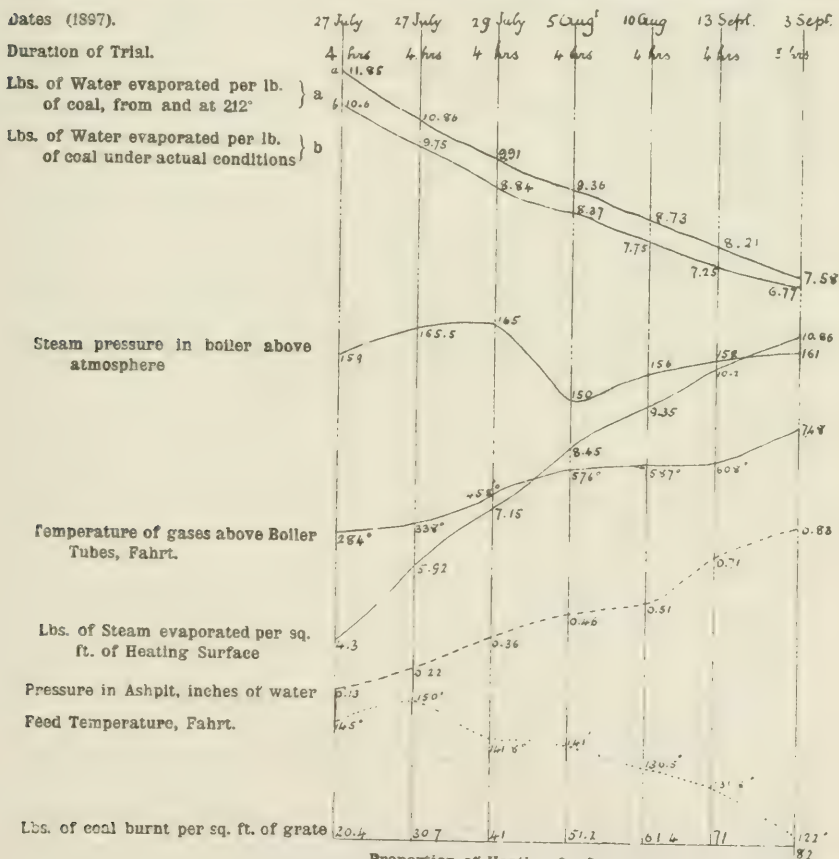
The circulating arrangements of the Niclausse generator, the direction of the currents of which is shewn on pages 341 and 343 by arrows, are all but perfect; the abrupt returns at the end of inner tubes and in the circulating chamber are the only objectional features. The inventor can claim, however, that the difficulty of examining, removing, and replacing the small tubes if the small-water-tube type is a defect that more than offsets the gain due to the generally satisfactory circulating arrangements of that type; he is perfectly justified in arguing that the circulating arrangements of the Niclausse generator are really very satisfactory, from the remarkable results obtained—for instance, those of the French torpedo boat *Téméraire*.

In this vessel no less than 84 pounds of coal were burnt per square foot of grate surface, and for ten consecutive hours, and this under the official supervision of officers of the French Government. The larger tubes, which were 4 inches in diameter, were not in the least deformed—a crucial proof of circulation excellence.

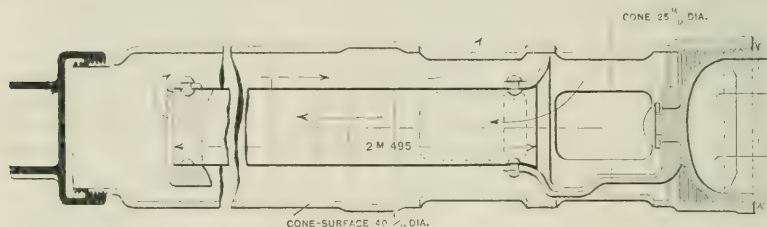
The absolute separation of the descending currents of cold feed water and ascending currents of hot water and steam is effected by the dividing partition in the collector header of each tube group, clearly shown on page 343. The steam and hot water ascend without appreciable resistance to the collector drum. In the Niclausse arrangement there is little probability that water will be carried from the drum into the steam pipe and to the engine cylinder. The possi-

bility of such an occurrence in any type of boiler should at once condemn it. Another characteristic is the absence of most of the auxiliaries which constitute such a conspicuous feature of the Belleville boiler; less detailed or skilled attention is therefore required in the Niclausse type. Firemen strange to the Niclausse boiler have no difficulty, it is asserted, in maintaining the full steam output. I consider, however, that the accident on the Italian cruiser Garibaldi justifies the provision of some simple and practicable form of automatic feed.

The question of the comparative evaporative value of the various tubes in different superposed positions above the fire grate is of great importance, and experiments made by M. Niclausse have determined the ratio between the several rows under varying conditions of forced



blast. The results, which are graphically illustrated on this page, are here given; it will be obvious that they bear upon the question of the advisability of employing an economiser if the combustion over the



IMPROVED NICAUSSE TUBE ARRANGEMENT.

The sleeve is made in one piece with the large tube, the whole being made of mild steel, gaps being cut to provide for the flow of water. The inner tube is attached to the inside of the cap of the large tube, one cap serving for both tubes.

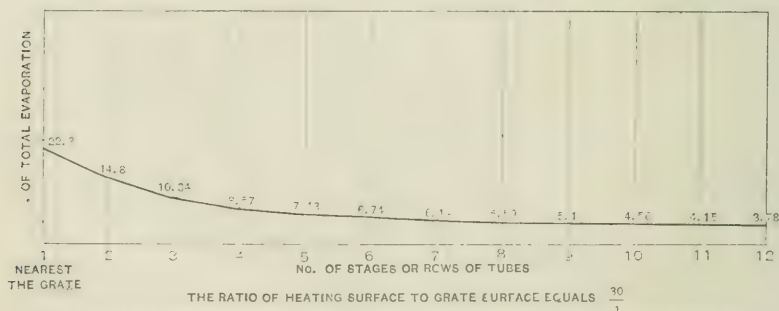
grate is perfect. In the tests, a special generator of 12 stages of tubes was employed, each stage being fed with water and also delivering its water independently.

The first row of tubes nearest the firegrate evaporated 25 per cent. of the total.

The first three rows of tubes, having a heating surface of 7.5 square feet for each square foot of grate surface, evaporated..... 50 per cent. of the total.

The first six rows of tubes evaporated..... 66 per cent. of the total.

The top row of tubes evaporated only..... $3\frac{3}{4}$ per cent. of the total.

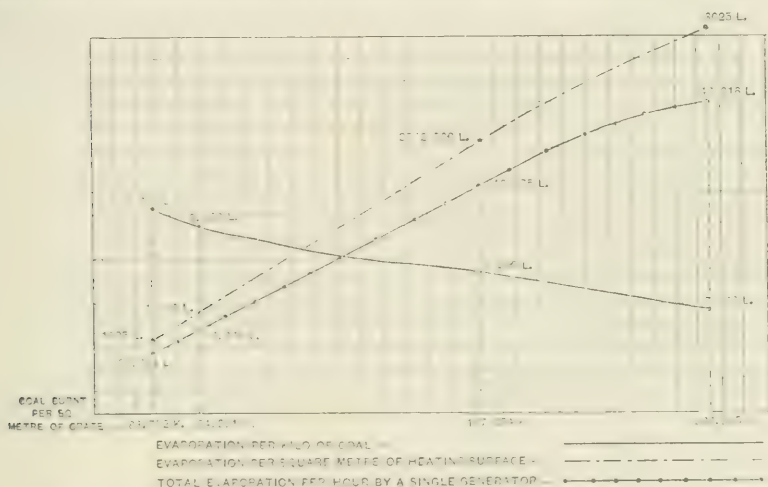


GRAPHIC REPRESENTATION OF THE COMPARATIVE EVAPORATIVE VALUE OF VARIOUS ROWS OF NICAUSSE TUBES

The important fact ascertained from these interesting experiments is that with grate-surface rates of combustion varying from 10 pounds to the square foot of grate up to 61 pounds, the proportionate evaporation was almost exactly the same for each variation.

The Niclausse generator of the French battleship Friant was in 1898 subjected to a crucial test which it is just should be briefly men-

tioned here. During the naval manœuvres two years ago the minister of marine suddenly and without the least preliminary notice, ordered the *Friant*, although it had just returned from a three-years' period of active service, to take part in the naval evolutions and undergo as a preliminary a continuous run of a duration of six days and nights at a speed of 16 knots, and to finish off with an additional run of 17 knots, and then to be subjected to a close structural examination. After the



EFFECT OF INCREASE OF COMBUSTION PER SQUARE FOOT OF GRATE SURFACE UPON THE EVAPORATIVE EFFICIENCY OF A NICLAUSSE BOILER. RÉSUMÉ OF FRENCH OFFICIAL TESTS.

evolutions the tubes were tested with a straight edge and found true, no signs of deterioration exhibiting themselves; the result of the test was considered entirely satisfactory.*

The following modifications of the Niclausse boiler might be suggested:

1:—The combustion space—height from grate to first row of tubes—might with advantage be enlarged, especially if coal containing a notable percentage of hydrocarbons is used. A secondary air supply over the fuel in the grate might with advantage be added.

2:—A simple form of automatic feed might supplement the firemen's personal attention in securing a regular feed-water level.

3:—The replacement of malleable iron with mild steel is advisable, and is to be adopted.

* The Russian cruiser *Variag*, built by the Cramps, is equipped with 30 Niclausse boilers divided into four groups; the total number of tube elements is 426, each one having 22 tubes 2 m. 20 long and having a bore diameter of 82 mm. The official test gave a true maximum speed of 24.6 knots. In a continuous run of 7½ hours with natural draft the speed was equal to 20.3 knots.

4:—No special provision is made for the accidental incursion of sea water. The makers no doubt think it is unadvisable to load their generator with auxiliary apparatus to meet conditions such as the incursion of sea water, which should not be allowed to exist under any circumstances.

The Dürr Water-Tube Boiler. The German naval authorities have adopted the Dürr boiler for several of their battle-ships and cruisers, including the armoured cruiser Prinz Heinrich, now building, the battle-ship Baden, 6,000 indicated horse power, the Bayern, 6,000 indicated horse power, the protected cruiser Vinetia, 10,000 indicated horse power, and the protected cruiser Victoria Louise, 10,000 indicated horse power.

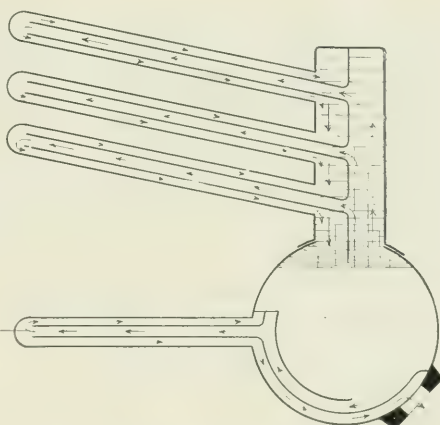
Apparently Herr Dürr, in the design for the main feature of his generator, the duplex tubes (misnamed by some Fields tubes), has drawn a feather from the quiver of Niclausse; indeed, a description of the Niclausse broadly covers the Dürr type, but there are considerable differences in detail; for instance, Herr Dürr inclines his duplex generator tubes from right to left, reversing the Niclausse inclination—see page 349. Again, instead of vertically grouping or sectionalising his duplex tubes in pairs, like Niclausse, to form elements, he builds up a single-front steel-box collector and distributor which he divides vertically into two halves, as shewn on page 349, by a central division plate, into which he introduces all the tubes; the front connector box is stiffened by stay bolts as shewn. Another innovation, and one of a decidedly ingenious character, is the employment of a duplex tube to effect the superheating of the steam; this duplex tube, as shewn in the figure, projects from the steam drum.

Herr Dürr's last iron-gridded and inclined iron back plate to support the rear ends of his tubes is arranged to allow them to have free and unrestricted play for contraction and expansion. In the absence of structural details little further reference can be made to this modified Niclausse—the Dürr steam generator.

One obvious objection to bringing all his tubes into one single col-

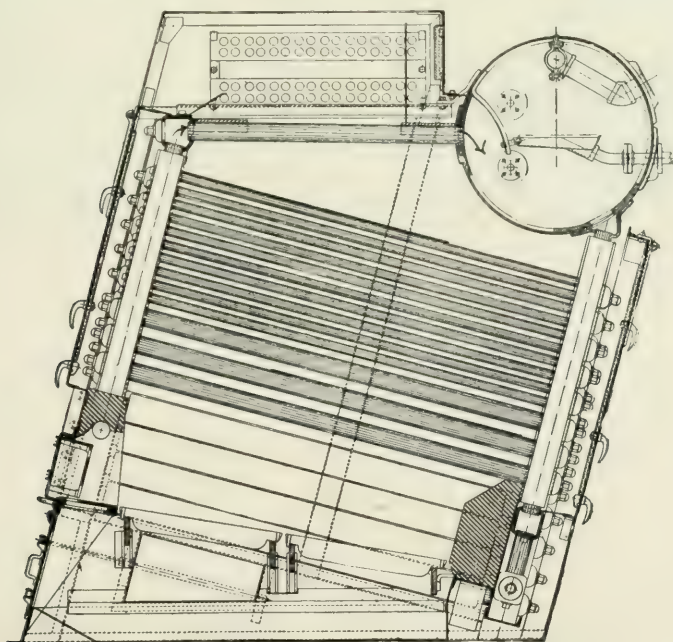
The Niclausse has been adopted for two of the British cruisers of the first class of the type of the Monmouth, 22,000 indicated horse power. France has adopted the Niclausse in the battle-ship Marceau, 12,000 indicated horse power. She has building the battle-ships Suffren and Henri IV., the former 16,200 and the latter 11,200 indicated horse power, the armoured cruisers Condé and Gloire, both of 20,500 indicated horse power, and the Gueydon, 19,600 indicated horse power. Russia is building the battle-ship Retvizan, 17,000 indicated horse power and the Variag, just completed, is a protected cruiser of 20,000 indicated horse power. Italy has just completed her armoured cruiser Garibaldi, 13,500 indicated horse power, and is building a battle-ship, the Regina Margherita, 19,000 indicated horse power. The United States have adopted the Niclausse for the new battle-ship Maine, 16,000 indicated horse power.

lector is that, in the event of a tube bursting, all the water and steam contents would be ejected on to the fire and this would mean a serious disaster. Besides, if the density of the water through the admission of impure feed is allowed to become too high, there will be a deposit in the box collector not so easy to remove. Herr Dürr has been very successful in building for stationary services a



DÜRR DUPLEX GENERATOR TUBES, SHOWING
CENTRAL DIVISION PLATE.

type of boiler somewhat on the lines of the Babcock & Wilcox, but with the addition of a horizontal small-pipe superheater, superposed over the main steam generator on the chimney-flue connection. Some of the dimensional details of the Dürr marine type of boiler are given further on in the tables of comparative efficiency.

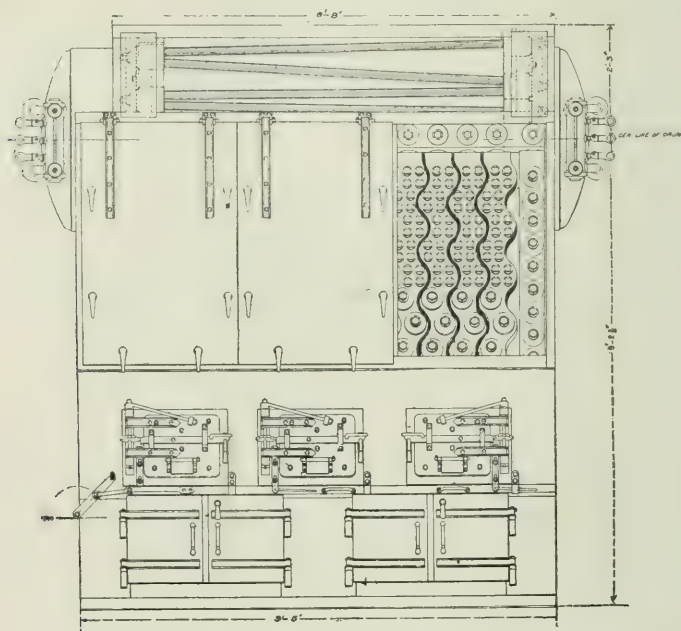


SECTIONAL ELEVATION BABCOCK & WILCOX WATER-TUBE BOILER.

The Babcock & Wilcox Boiler. Although credit has been given to M. Belleville for his pioneer work in introducing the large-water-tube boiler into the French navy, it should not be overlooked that much of the confidence in the water-tube boiler, as distinct from the shell type, has been won from prejudice by American engineers, to whom we are indebted for the Babcock & Wilcox and the Root water-tube boilers. The introduction of the Babcock & Wilcox must have been made considerably over quarter of a century ago, and since then this type of boiler has been applied to the extent of hundreds of thousands of horse power for stationary or land purposes. The application of a modification of this type for naval purposes is quite modern and is therefore limited.

I will confine myself to the description of the application of the system on the United States gun-boat Marietta, that constituting the advanced stage in the evolution of the system. The general design will be understood by reference to page 349 and the cut below.

The straight generator tubes, single, like the Belleville, are connected to wrought-steel front and rear headers. The shape of the headers is square in section, elongated in a sinuous form and constituting a water collector for a group of tubes or elements. Openings



FRONT ELEVATION, BABCOCK & WILCOX WATER-TUBE BOILER.

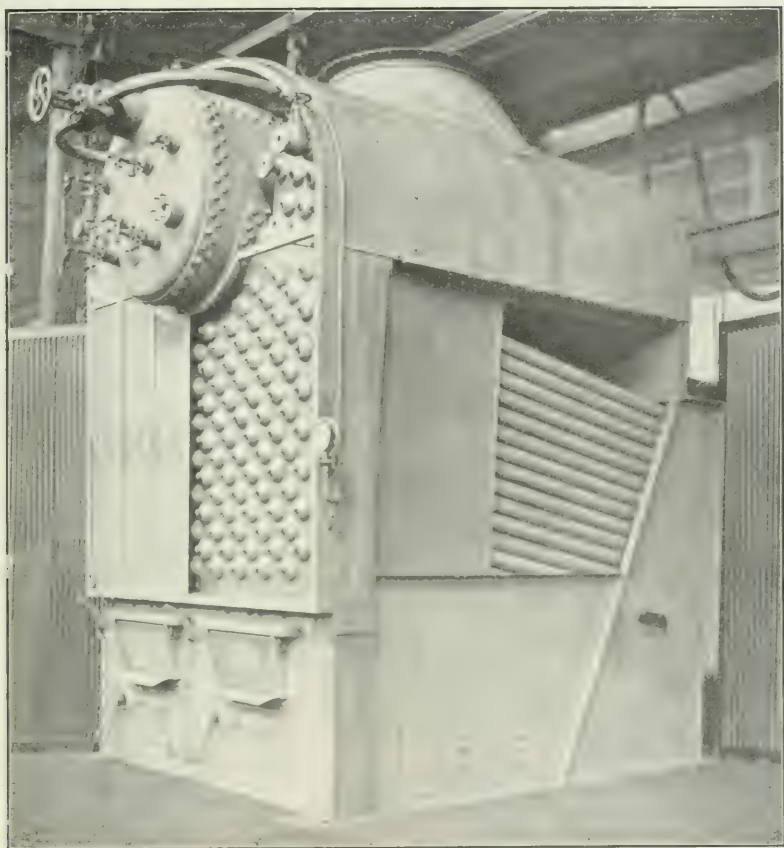


FIGURE WATER-TUBE BOILER WITH PART OF CASING REMOVED.

are provided in the collectors or headers opposite the ends of each to permit of their internal examination. The angle of inclination of the tubes is 1 in 4. The tubes are expanded by means of ordinary roller expanders into the headers, and in this respect are at a disadvantage compared with the Niclausse and its conical tube connections, because the removal and renewal, unless it is effected by a skilled artizan, will occupy considerable time.

The front and rear headers are connected to the steam drum, the former by a short and the latter by a longer length of pipe. The steam drum defines the working level of the water, being maintained half full. The direction of the circulation of the currents of hot water and steam is indicated by arrows. The superposed-economiser practice of the Belleville finds its counterpart in this design in the installation of a

group of small feed-water pipes superposed over the main generator, through which the feed water is pumped.

The Marietta has performed satisfactory trips, one of which involved a voyage of 11,000 miles, from San Francisco to Key West. This was done at 13 knots, one knot over the contract speed. During this voyage it is stated that it was never found necessary to slow up for boiler repairs, and that at the end of the trip the generators were practically as perfect as at the commencement of the voyage.*

Small-Water-Tube Steam Generators. In the small-tube type of steam generators the lines laid down by theory to obtain first, a perfect cycle of circulation; second, a high velocity of the circulating currents; third, satisfactory provision for the effects of expansion and contraction, and fourth, a high degree of heat-utilisation efficiency, are more closely followed.

For example, the cycle of circulation is more direct. The small generator tubes, in the later designs, are approximately vertical and there are fewer abrupt bends or diversions to upset the motion of the circulating water. They are so devised that they can freely expand and contract without breaking the end joints.

The circulating effect is so considerable as to establish a more uniform temperature throughout the metallic structure of the steam generator. There is provided far greater cubic space for combustion effect than is common with the large-tube type, and there is better provision for the introduction in the combustion space over the grate of a well-distributed secondary air supply. The velocity of the water through the small tubes is such that the interior of the tubes is scoured, removing deposited matter that may be precipitated during intervals in steaming. It is of course understood that the water for

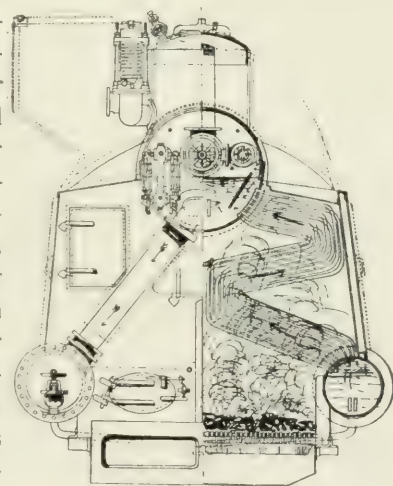
* In the Marietta Babcock & Wilcox boilers there are, as will be seen, two stages of tubes of different diameters. The first stage consists of three rows of tubes immediately above the fire-grate, 4 inches in diameter (6 B. W. G. thickness). The second stage consists of ten rows of tubes 2 inches diameter and 8 B. W. G. in thickness.

The tubular economiser fitted up in the up-take has 233 square feet of heating surface. The heating surface of the boiler is 1,810 square feet.

Length of generator.....	11 ft. 6 in.
Width	9 ft. 6 in.
Height over all.....	11 ft.
Total firegrate surface.....	95 sq. ft.
No. of 4-inch tubes in generators.....	57
No. of 2-inch tubes in generators.....	260
Length of tubes.....	7 ft. 6 in.
No. of 2-inch tubes in economiser.....	64
Length of 2-inch tubes in economiser.....	6 ft. 8 in.
Total weight dry.....	94,016 lbs.
Charged with water.....	112,016 lbs.

these small-tube generators is never allowed to attain any great density; otherwise it is easily conceivable that during periods of non-steaming the deposits might actually choke the small tubes. It is of the highest importance, if the best efficiency is desired, that the water should be as free as possible from depositable suspended matter.* In the earlier designs of the small-tube generator the tubes were not arranged in an easy curved, straight, or vertical line, and this is the defect that conspicuously characterised Du Temple's pioneer inventions. To John Thornycroft is due the merit of the innovation in design which included the use of more-nearly vertically arranged, if also curved, generator tubes.

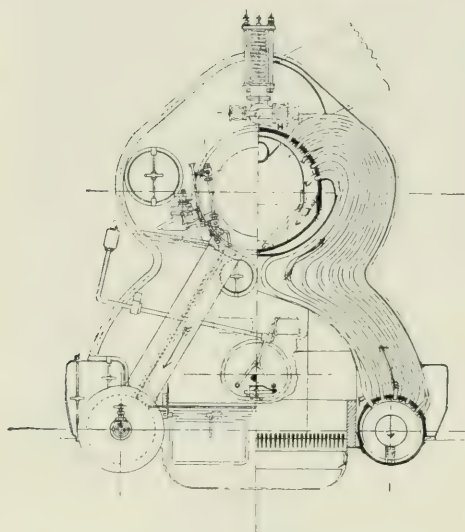
The Du Temple Boiler. Commandant Du Temple's latest form of his generator is shewn below; he has unfortunately retained the zig-zag form in his generator tubes, with their abrupt curves and short, almost horizontal portions. This zig-zag form is structurally very defective. The small tubes are connected to the upper steam-and-water drum by joints formed of cones and nuts. The advantage claimed for this method of connection is its comparative facility for the rapid removal and replacement of the tube. The side or wing water-collecting vessels or barrels are provided with end covers permitting the lower portion only of the tubes to be examined and cleaned. The direction of the circulating water currents is clearly shewn by arrows; the down-comers are placed outside the main steam-generator structure and are



DU TEMPLE BOILER.

of ample capacity and, owing to the lessened velocity of the water currents, promote the deposition of suspended matter. In one design of his steam generators the lower part of the generator tubes is made less in diameter than the upper part, the intention being to provide an increased area for the flow of the gases of combustion. The Du Temple steam generator has not been largely applied for naval purposes;

* It is obvious that owing to the small volume of the water space compared with that in shell generators (which contain 10 to 15 times as much water as the water-tube type) any impurity becomes concentrated very rapidly and this alone demonstrates the importance of pure water being always used.



THORNYCROFT'S EARLY DESIGN.

it has, however, been fitted to one of the British gun-boats, the *Spanker*. Like many another inventor and pioneer, Commandant Du Temple has lived to see his invention—with modifications which it must be admitted are essential—applied on a grand scale. Du Temple's reward is one of honour rather than of ducats.

The Thornycroft Water-Tube Boiler. Although credit in generous terms has been given to Du Temple for his invention, it is due to John Thornycroft

to say that but for his enterprise and his pioneer work in applying the small-water-tube boiler to marine purposes it is very questionable whether this type of steam generator would have obtained the importance it has.

The salient characteristics of Thornycroft's steam generator are, first, the curvilinear form of the tubes (modification of the Du Temple), providing for linear dilation, and second, his method of delivering the water and steam from the generator tubes into the steam space *above* the surface of the water in the steam-and-water drum. By this latter striking divergence from Du Temple's practice, Thornycroft secured the maintenance of his cycle of circulation, as there is no possibility of the water's returning through any other than the return or down-comer tubes provided for this purpose.

Above is shewn Thornycroft's early design. The direction of the cycle of circulation of the water current is shewn by the full arrows. Like Du Temple, Thornycroft employed outside return or down-comer tubes, two large-diameter down-comer pipes being provided to lead the water from the upper steam-and-water drum to the side collecting vessels. Baffle plates fixed in the steam drum assist in separating the water from the steam ejected from the tubes. The steam pipe runs along the length of the drum or upper barrel.

A fairly generous allowance of space for combustion is provided

over the grate. In order to ensure that the gases of combustion are uniformly distributed over the generator tubes, the curves of the inner row of tubes on each nest are arranged in such a way that they gradually close upon each other just under the invert of the steam-and-water drum. The gases are consequently compelled to flow through the interspaces at the lower portion of the generator, instead of flowing directly through the interspaces at the upper part of tubes, which would be the result of equal

interspacing. The arrangement of graduated interspacing obtains fair uniformity of heat distribution.



JAPANESE DESTROYER SHINONOME.

generator tubes are brought close together so as to constitute a close wall. They open again at the top of the nest of tubes for the purpose of providing the necessary degree of interspace, and to permit the gases of combustion to escape to the chimney. The characteristic dimensions of the tubes used by Thornycroft are: External diameter, $1\frac{1}{4}$ inches; thickness, 0.128 inch; external diameter, $1\frac{1}{8}$ inches; thickness, 0.104 inch.

The feed water flows into the centre of the steam-and-water drum.

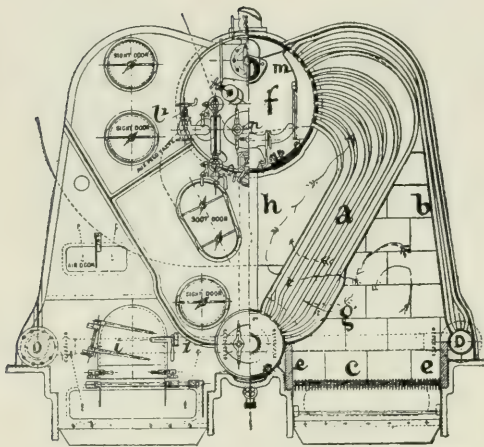


U. S. S. ALBATROSS.

It will be noted by the figure that Thornycroft provides a fire-guard plate fixed under the invert of the steam-and-water drum. The tubes forming the outside rows of gen-



U. S. S. BOXER ; CRUISER ASTERN.



THORNYCROFT BOILER, DARING TYPE. CROSS SECTION.

The Thornycroft boiler is covered in with light steel casings easily removable for repair and renovation.

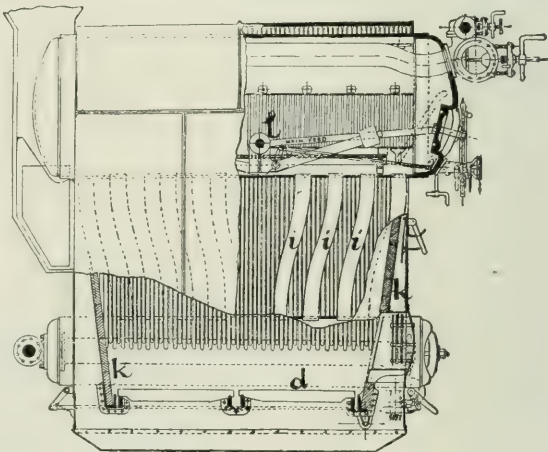
The tests of this generator in the British ship *Speedy* tend to shew that the portions of the generator tubes above the water level in the steam-and-water drum or barrel have an abnormal tendency to corrode; this action is doubtless due to the influence of air along with the

moisture from the wet steam. All surfaces intermittently exposed to water, or exposed to the effect of surface moisture, are liable to abnormal corrosive activity. In the *Speedy* the tubes had to be replaced in four years from the date of her commission.

Another feature of the lessons gleaned from the trial of the *Speedy* is the fact that the incursion of sea-water into the feed initiated the undesirable action of priming; the same effect would occur, of course, for the same reason, in other small-water-tube boilers.

The fuel-utilisation efficiency of Thornycroft's steam generator has been repeatedly determined with non-hydrocarbonaceous fuel, and the results, thanks to the adequate combustion space provided, can be considered satisfactory.

A decided innovation appears in a more recent design of this boiler which is known as the Daring type. The object in this new design was to obtain increased grate and



THORNYCROFT BOILER, DARING TYPE. LONGITUDINAL SECTION.

heating surface in a given cubic space. The Daring type is sectionally shewn on the opposite page. The chief characteristics differentiating it from the first design are conspicuously shewn. Instead of two collecting water vessels or barrels, there are three, of which the central one may be larger than those at the wings or sides, though in the latest designs all are of the same diameter. The side water vessels receive the terminals of the three rows of tubes constituting the outside walls of the steam generator. Two of the three rows of tubes constituting the side tubular walls actually touch each other. The two principal nests of generator tubes, right and left of the central collecting vessel, find their lower terminations in the central collecting vessel. These nests of tubes, owing to the disposition of their curved parts, provide what may constitute a secondary space for the combustion and distribution of the flow of the gases. The direction of flow of the gases follows the lines indicated by the dotted arrows, the closure and enlargement of the inter-tubular spaces preventing them from following any other direction. It will be seen that the sensible heat of the gases will be very considerably reduced by the time they have traversed the tubes in the direction indicated.

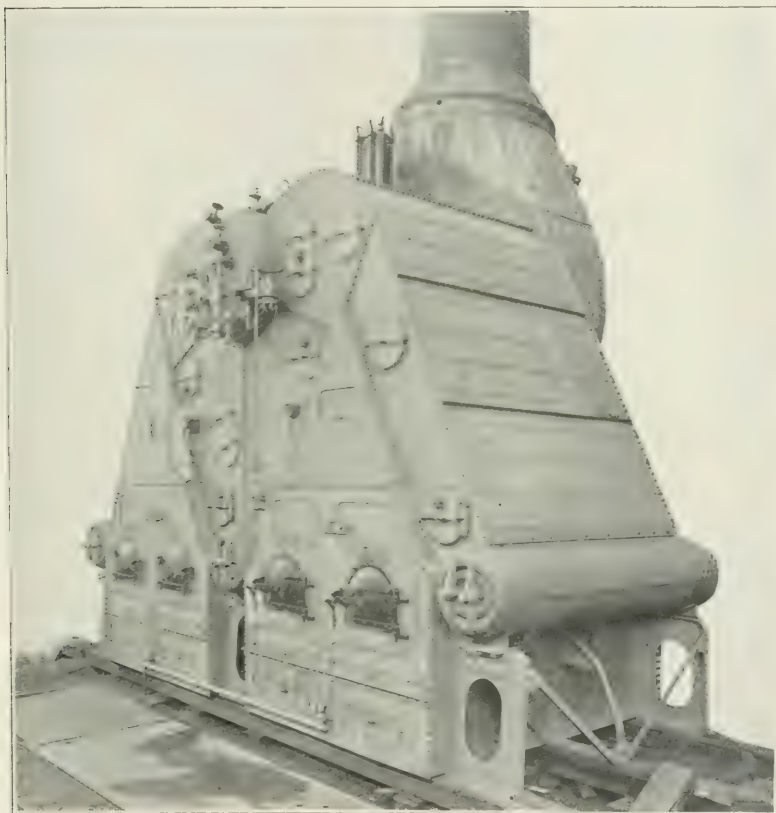
In this earliest of the Daring type of steam generator, Thornycroft has eliminated the outside down-comer return-flow pipes, employing instead a series of vertical pipes passing directly and centrally from the invert of steam-and-water drum to the central collecting vessel; this latter is connected to the small outside collecting vessels by means of horizontal pipes.

With coals containing an appreciable proportion of hydrocarbon in their constitution it is quite possible that the central space, acting as a secondary combustion chamber, might attain a higher temperature than the two side and primary combustion zones. Under such conditions the series of return pipes might possibly become heated to such an extent that the evaporation would tend to produce a disturbing effect on the cycle of circulation. Part of the water, instead of descending, would, by the bubbles of steam, be forced upwards to the steam-and-water drum. The culminating effect would be a tendency to produce the dangerous priming action.

The method of separating the steam and water differs from that in the original type.

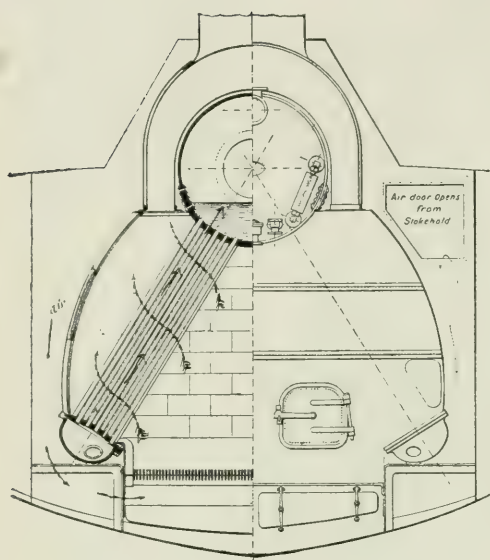
In the latest modification of the Daring type the salient features of difference are the reintroduction of the outside down-comers or return pipes, whilst the series of centrally placed down-comer tubes are re-

particular type of water-tube steam generator for naval purposes. There is, however, a marked distinction between the Yarrow and the Thornycroft steam generators. For example, in the former the small generator tubes, 1 inch to $1\frac{1}{8}$ inch external diameter, have all their upper terminations below the water level of the steam-and-water drum, and the tubes are thus what is technically termed "drowned" (p. 360). In the other type, as just described, the generator tubes are connected to the upper space above the water level of the steam-and-water drum.



THORNYCROFT BOILER, DARING TYPE, ERECTED AND CASED IN.

In the Yarrow, the steam-and-water drum (as in the Du Temple and Thornycroft steam generators), is placed over the centre of the grate, receiving the upper terminations of both nests of generators. The steam-generator tubes connecting the steam-and-water drum with the side or wing collector vessels at the foot of each nest of tubes are, as will be seen, straight. The side or wing collector vessels are half



YARROW SMALL WATER-TUBE BOILER.

round in section; the vessels are completed by an upper flat plate, placed at right angles to the tubes constituting the tube plate, and into which the tubes are expanded. The outside groups of the two groups of tubes serve as the down-comers or return tubes. No separate large down-comer pipes are provided, although in some instances Yarrow has provided stay tubes of larger diameters than the small generator tubes, which are made to act as return tubes. In order to separate more

definitely the two ascending and descending currents of water when they reach the collector vessels, a diaphragm has been introduced which prevents the confusion of the currents.

The enclosing outside casings of the Yarrow steam generator are removable, either altogether or partially, and they permit easy access to all the steam-generator tubes. In order to reduce the loss by radiation, the side casings are internally lined with asbestos and the end casings with firebrick. Yarrow boilers have been installed in cruisers of the Dutch Government. One valuable feature of this generator is the ample space provided for primary combustion. The diameter of the small generator tubes varies from 1 inch to $1\frac{1}{4}$ inch.

The Normand Small-Water-Tube Boiler. This type combines the characteristic features of the Du Temple, the Thornycroft, and the Yarrow designs, along with certain other innovations more especially relating to the combustion arrangements. Mr. Normand has certainly approached the subject of designing an ideal boiler in a thoroughly scientific manner; he has analysed the various conditions that have to be satisfied, and his design is a declared attempt to meet them in as complete a manner as practicable.

The generator tubes are 1 inch internal and 1.3 inch external diameter. The form of the tubes is composite; some of them are practically straight, others are curved. The tubes enter the upper steam-

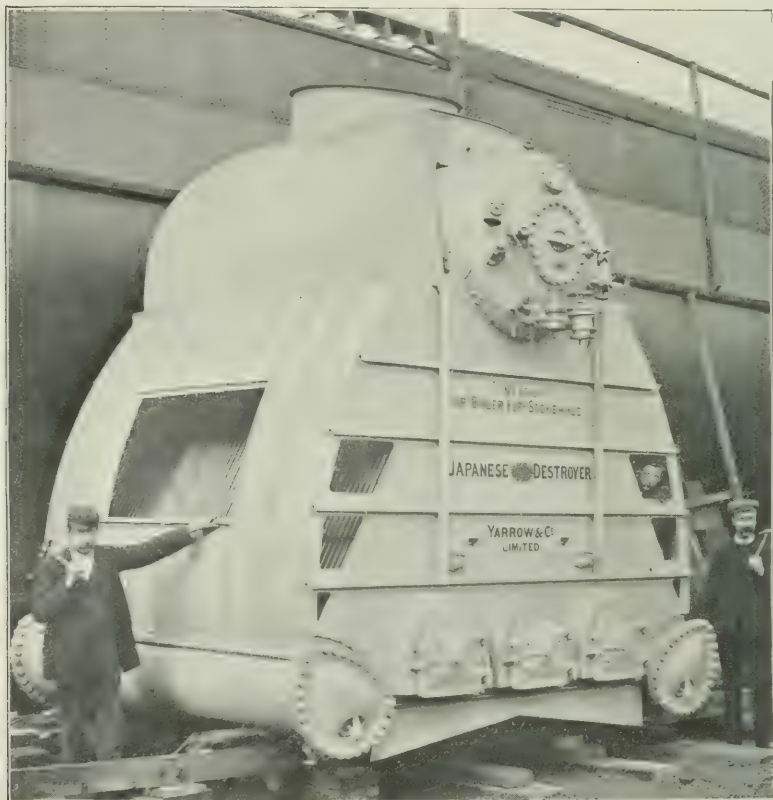
TABULATED DATA GIVING COMPARISONS BETWEEN TYPICAL SHELL BOILERS AND THOSE OF THE LARGE AND SMALL WATER-TUBE TYPE.

	Shell Generator, Martin type.	Shell Generator, Ellis & Eaves	Shell Generator Howdens.	Water-Tube Belleville.	Water-Tube Belleville.	Water-Tube Babcock & Wilcox.	Water-Tube Babcock & Wilcox.	Water-Tube Thornycroft.
Dimensions (Outside).....	15' 2" x 19' 6"	14' 9" x 20'	13' 0" x 19' 6"	.....	.....	.....	.....	.....
Number and Character of Steam Generator.....	4 double ended cylindrical.	4 double ended cylindrical.	4 double ended cylindrical.	12	18	10	12	8 single ended.
Character of Draft.....	INDUCED.	INDUCED.	FORCED.	FORCED.	NATURAL.	FORCED.	NATURAL.	.....
Heating Surface, Sq. Ft.....	20,000	20,000 (?)	15,400	21,000	31,500	27,000	32,400	28,000
Number of Sq. Ft. of Heating Surface, per ton of Boiler...	55.6	.....	50.4	140	150	135	131.8	266.6
Number of Tube Groups or Elements, Dimension of Tubes.....	.....	.....	.....	11 Elements Made up of 4 tubes, Econo- miser tubes 2 1/4.	11 Elements, Made up of 4 tubes, Econo- miser tubes 2 1/4.	.....	.....	.....
Area Grate Surface, Sq. Ft.,	536	.....	436	633	950	615	738	480
Ratio of Heating Surface to Grate Surface.....	37.1	.....	35.1	33.1	49.1/1	44/1	44/1	58.4/1
Equipped with Economisers	No.	No.	No.	Yes.	Yes.	No.	No.	No.
Weight of Boiler in tons dry	350	410	267	150	206	200	246	105
Weight of Boiler in tons with Water	518	550	300	172	238	266	325	122
Air Pressure under Grate, inches of water.....	1' - 1 1/2"	... ..	1' - 1 1/2"	3 1/4"	.....	1' - 1 1/2"	.....	1' - 1 1/4"
Steam Pressure, lbs. per sq. in.....	200	200	260	260	200	200	200	200
Consumption of Fuel (Coal) per I. H. P. in lbs., (46 lbs dry steam per I. H. P.)	1.06	1.61	1.33	2.1	1.75	2.00	2.00	2.06
I. H. P. developed per Sq. Ft. Grate Surface.....	18.65	18.63	22.01	15.8	10.52	16.26	13.5	20.62
I. H. P. per ton of Boiler (16 lbs dry steam per I. H. P.)....	17.57	15.57	21.01	34.4	23.60	27.94	22.82	59.5
Ratio Heating Surface to I. H. P. developed.....	2.1	1.1	1.54/1	2.1/1	1.75/1	2.01/1	2.01/1	2.06/1

* There is probably an error here; the calorific value of steam coal would not permit such a result to be obtained in regular work every day.

and-water drum beneath the water level, as in the Yarrow design. The side or wing water collectors at the base of the tubes are cylindrical. The arrangement of external water-return or down-comer tubes is similar to Du Temple's design. There is no special arrangement provided for effecting the separation of the steam and water.

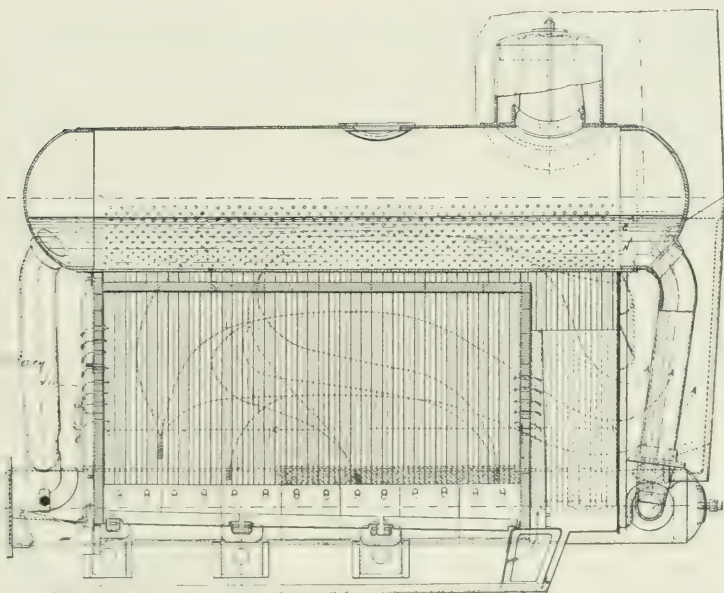
The gases of combustion follow the direction indicated by arrows drawn on the figure. The end walls of the combustion chamber are



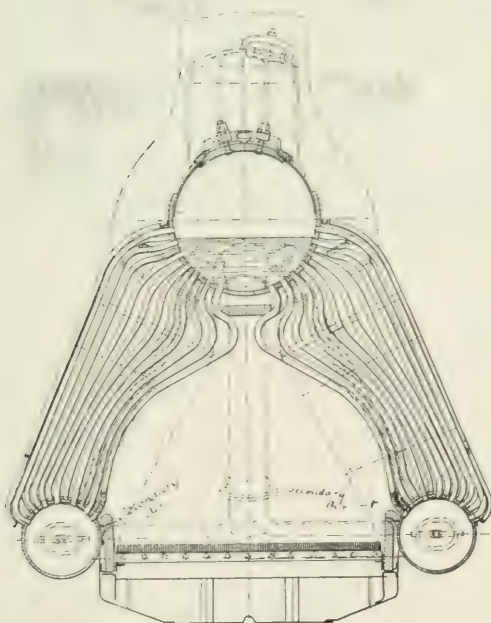
YARROW WATER-TUBE BOILER OF 1,600 HORSE POWER.

made with refractory tiles, and similar tiles supported by the generator tubes protect the inverted side of the steam-and-water drum from the direct effect of the flames. The flow of the gases of combustion is different from that in the other designs. The gases flow around the tubes and along the inside of each side casing to one of the ends of the generator, where they are directed to the funnel.

A secondary air supply is provided, air-inlet openings being pro-



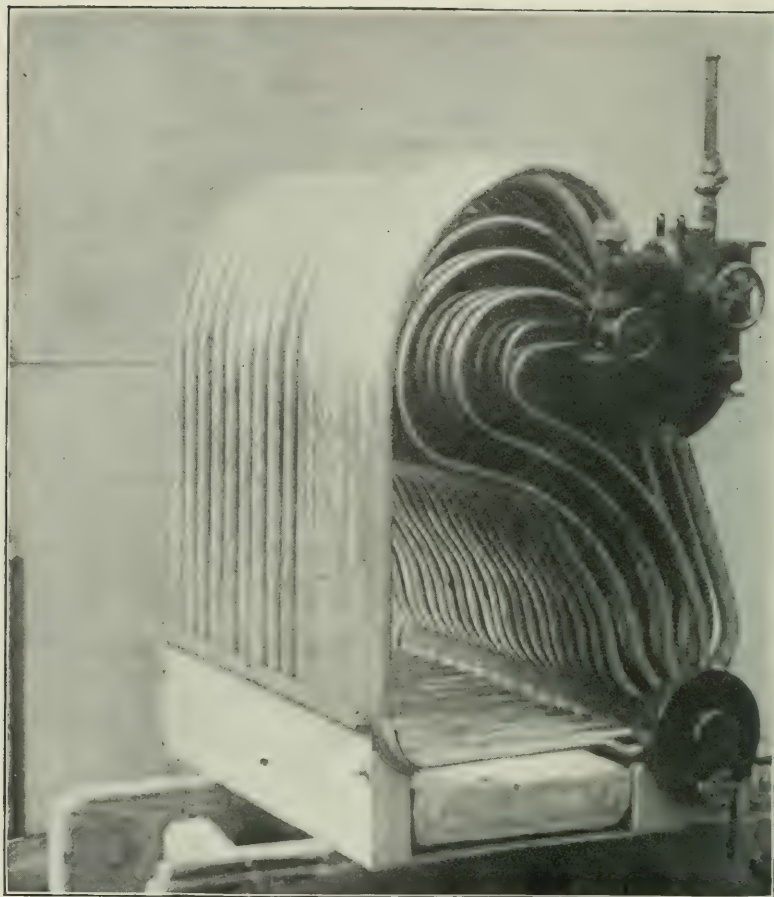
LONGITUDINAL SECTION, NORMAND SMALL WATER-TUBE BOILER.



CROSS-SECTION OF NORMAND BOILER

vided in the firebrick or refractory tiles along the grates. This secondary air supply was first invented and applied by the author, and fully described by him at the last Edinburgh meeting of the British Association.

This feature of the Normand steam generator is certainly praiseworthy, and by its aid M. Normand should have little difficulty in securing the perfect combustion of the hydrocarbon contents and in obtaining a high degree of thermal utilisation.



THORNYCROFT BOILER, LAUNCH TYPE, IN WHICH THE WATER TUBES SERVE AS GRATE BARS.

M. Normand also introduces air through the end walls, special apertures being provided for this purpose. An inverted refractory bridge pierced with apertures forces the gases to pass around the lower part of the generator tubes before passing to the funnel. Generous provision of space for combustion secures a satisfactory figure of evaporative efficiency.

THE EXPENSE ACCOUNT OF THE MACHINE-SHOP.

By H. L. Arnold.

IT would seem at first sight to be an easy matter to determine whether a given factory expenditure should be charged as a loss, or credited as a permanent gain to the business. When, however, all of the aspects of any factory operation are considered fully, it will be seen that there may be strong arguments for regarding some particular item or items of expenditure as either loss or gain, according to the angle of observation. This Janus-faced expenditure item is more likely to appear in the machine-shop than in the simpler manufacture of textiles and so on, where all material purchased has a certain pretty constant waste percentage, and all direct labor expended goes unequivocally to the production of salable merchandise. Precisely the same conditions occur in some classes of metal-working establishments. Generally speaking, it may be said that all cases of simple repetitive manufacture with variations which are but slight, or with no variations whatever, involve fewer doubtful items of outlay than do those factory operations which lead to the production of improved new things, although, when a close examination of certain items of textile-factory outlay is made, it will be seen that there are plausible arguments for charging them as permanent losses or unproductive expense, or for crediting them as permanent gains and highly valuable assets.

Take advertising expense, for instance. Obviously there can be no increase of salable factory product gained by money spent in advertising, hence advertising should be charged directly to expense; that is one view. A view which includes the probabilities of the future shows at once that past advertising extends and increases the probabilities of orders for the factory product in the future, since the recognition and good will of the purchasing public are certainly at the very head and front of valuable factory assets.

It is, however, more noticeably the case that accountants disagree in a very marked manner over the final disposition of large items of

Mr. Arnold, in this article, deals with probably the most important subject in machine-shop accounting—one, at least, whose misconception has the largest possibilities of disaster. The paper now presented is from the advance sheets of Mr. Arnold's comprehensive work, "The Complete Cost-Keeper," dealing with principles and systems of factory accounting and the aids thereto, published by THE ENGINEERING MAGAZINE Press, Nov., 1900.

factory expenditure where there are certain tangible factory residues left in possession of the factory after the completed finished product has been delivered to the customer and paid for by him.

Suppose, in the instance of a machine-tool factory, an order is received for a lathe of certain dimensions, and that because a lathe of that particular size has not been hitherto produced by this particular factory, or because the superintendent desires a better product, or for any other reason, the factory decides to fill this order with something different from anything it has before made. Similar cases arise constantly, and will continue to arise for a long time, perhaps forever, since it is never safe to say that the final best form of any machine product has been reached.

It having been decided to fill the lathe order with a new creation, the usual shop procedures are begun. First, the new lathe receives arduous and costly attention in the drawing room, involving the severest labor of the highest talent available, with a correspondingly large money expenditure, resulting in the production of the drawings requisite for the building of the improved lathe. Next the drawings go to the pattern-shop, and a costly set of patterns is produced for the use of the foundry, which finally furnishes a set of castings to the machine department, and the actual construction of the new lathe itself begins. The lathe is finished, delivered to the customer, is satisfactory and is paid for at contract price, and the establishment building this successful lathe has remaining in its possession the drawings and patterns therefor, which may have cost more than the whole price paid by the customer.

At this point of this transaction, the actual case is very possibly this: the lathe builder has paid out more money in producing the lathe than the customer has paid for it, and the whole matter involves a loss, if the drawings and patterns are charged to the expense account. If, however, the lathe drawings and patterns are credited as shop assets, the whole transaction shows a gain on the books, although more money has been paid out than has been paid in, and if an actual cash gain is to be had on the transaction it must come from future operations, involving the use of the costly drawings and patterns left in possession of the factory.

The questions arising from this simple example of filling the lathe order appear in connection with all factory equipment. At the time a new factory plant has been installed and before production and sales of product begin, the total investment represents, in point of fact, a total loss, and unquestionably should be charged directly to expense.

and this is in some cases done, and the whole cost of an extensive factory equipment, outside of the forced-sale-value estimate of the ground and factory buildings, is written into the expense account, thus making the concern a bankrupt on the face of its own accounting, or, if not a bankrupt, because of faith and yet unexpended capital in the hands of its projectors, a heavy debtor with no assets. This is the actual position of the new factory not yet in work, and if the factory accounting is based on the actual condition of time past and present, everything to date is an outlay with no return and must be written as a loss.

The expectation for the future is not an accomplished fact. It is a possibility, beyond any question, and a clear probability in the minds of those capitalists who have invested in the factory plant. It may even be said correctly to be as likely to produce profitable returns as any human effort can be, and yet the fact is that when the factory opens its doors to begin production its books must show simply an outlay with no return.

Going back to the lathe order: at a subsequent period we may find that the patterns and drawings have proved to be assets in constant profitable use; the lathe may have been found extremely suitable, and many duplicates may have been ordered, and the whole transaction at this period may show a large gain. On the other hand, the lathe may have met with only a special and rarely-occurring demand. There may have been few orders for duplication, or none at all, and the drawings and patterns, instead of being valuable assets in constant profit-producing use, may have been wholly unproductive, and even a source of more loss in the way of insurance and storage room.

Hence it is very clear that the factory accountant who deals with facts and conditions of the present moment only will write the lathe drawings and patterns into the expense account, and thus make the transaction of filling the original lathe order show a loss, while the factory accountant who has hope and faith in the future will write the lathe drawings into the factory assets, because of his reliance on probabilities. And both proceedings are correct, and no difference in the future profits or losses of the lathe builder is made by writing the drawing and pattern costs either way. But in the one case the accounts show a gain which has not accrued, while in the other case they show a loss which at some future time may be recouped; hence either accounting may be shown in the future to be faulty.

If the case of the lathe order is carried to the extreme, and the lathe builder continues to work only on new orders without duplication, he

must, of course, transform his cash in bank into unused drawings and patterns, and cease to do business when his original capital is exhausted; and precisely this condition of affairs has occurred many times where the operations of a machine factory were directed by a really skillful and able machine designer, whose every individual creation was an operative success, and who well and worthily sustained his high reputation as a mechanician.

In this lamentable and not infrequent case, the ingenious manager may fancy up to the last moment of open doors that he is in a prosperous financial condition, because his books show large gains in the way of shop equipment which are his very own. He says to himself: "All of these machines which I have produced have been good, have given satisfaction, and the drawings and patterns and special tools for their production must certainly be of great value, because they will enable me to produce future duplications at a large profit." But this ingenious and able machine designer has not the commercial instinct which leads him to devote his energies to the procurement of orders for repetitions of his work; on the contrary, the natural trend and bent of his mentality is to produce new things and ignore the successes of the past, and if left to himself, bankruptcy is much more probable than commercial gain.

The other extreme is found in the factory managed by the mind of purely commercial instincts—the mechanical mind and the commercial mind being as far asunder as the poles, both in their motives and methods of procedure. The man of mechanical mind conceives the idea of a real and valuable improvement, embodies it in usable form, scores an unqualified success, and washes his hands of the whole matter; he has unriddled the riddle, is satisfied with his effort, and either quits it and goes on with something else, some new problem seized by his active mind, or sees further improvements and refinements to be made, which may be mechanically correct, but do not add very much to the working value of his first achievement and so make no money. The commercial mind sees the money possibilities inherent in the new production of the mechanical mind, and gives its whole efforts to the securing of orders for duplications, declaring the present production to be not only the best thing that ever was, but the best thing that ever can be, and setting its face like a flint against any change, and so does secure orders for repetitions and makes money by advocating established practice.

The commercial mind and the mechanical mind are often associated as equal powers in factory management, and sometimes achieve

commercial success where thus associated on even terms. A money success is, however, much more likely to eventuate where the deciding authority lies with the commercial mind, while the mechanical mind is left at liberty to evolve new creations, being capitalized and supported by the sale of duplications of past successes, on orders secured by the efforts of the directing commercial mind.

If the accounting is directed by the purely commercial mind, the cost of developing new ideas is invariably charged into the expense account, because the commercial mind instinctively and naturally conforms to actual commercial conditions and fully realizes the possibility of forced sales with the factory doors closed.

A going concern has intangible assets in the way of good will and custom, which are undoubtedly of the very highest value so long as the business continues with open factory doors. At a forced sale these intangible assets become utterly valueless. They shrink to nothing and disappear as completely as if they had never existed, although they were the very life and breath of the business while it continued to be operative.

In the case of a forced sale, drawings, patterns, and special factory tools are found to be absolutely without buyers. The drawings are not worth so much as the rolls of blank paper on which they were made. The patterns are not worth so much as the lumber used in their construction cost, and the special shop tools and fixtures, so highly valued by the fine mechanical mind which produced them, will not sell for so much as would the iron in the pig and the steel in the bar of which they were made. Yet where the accounting is directed by the mechanical mind it will invariably be found that shop tools and appliances are carried in the accounting of assets, in greater or less degree. In some cases a certain proportion of the drawing, pattern, and special-tool costs is charged to expense, and a certain other portion is credited as an asset. Small tools up to certain sizes will be found in some cases charged to expense, while above this limit the costs of similar tools will be carried as assets.

In point of fact, referring to machine patterns only, a large stock of wooden patterns is a source of constant expense, requiring great storage room—which must be neither damp, too cold, nor too warm—large insurance, and the care of one or more attendants, and individual patterns are often not used for years together, while at a forced sale these costly patterns would bring absolutely nothing. Yet it is a very common thing to find patterns appearing in factory accounts as assets of many thousands of dollars in value.

The prime object of factory accounting is surely to present to the eye of the manager a correct and faithful showing of the actual values under his control. Are those actual values the probable forced-sale realizations, or are they the radiantly-hopeful supposititious values dependent on good trade and an abundance of orders?

To the purely commercial mind, taking nothing on chances, the forced-sale value must appear to be the only proper value to be given to factory plant in the accounts. To the mechanical mind it seems preposterous to write all the cost of these highly-valued shop treasures directly into the expense account.

The one method makes the books show what could probably be realized if the factory doors were closed. The other method makes the books show the factory to be wealthy in many cases where it is really bankrupt. It makes no actual difference in the cash in bank whether these disputed items are written into expense or assets. Account footings are not cash. But erroneous assumptions as to values, leading to erroneous asset totals, are very likely to lead to errors in management, and surely the last thing in the world to be desired by a factory manager is a self deception, leading him to believe his cash resources larger, and even vastly larger, than they really are.

It is perfectly true that the first requisite of commercially-valuable factory accounting is itemization showing correctly in minute detail where the money goes. In the old days of the machine shop it was a common thing to keep a "shop" account, and charge this shop account with all expenditures not directly entering into the salable product. Both labor and material of every description went into this shop account, lumped together, and the footing told the manager the mere total of indirect expenditures, and gave no indication of possibly economical changes in factory methods because the various items of expenditure were not classified.

The modern factory accountant divides the items of indirect expense into building maintainance, plant betterments, machine repairs—which open a repair account with each department of the factory, with each detail of each department repair, and often with each individual machine—certainly with each separate class of machines in the factory plant—and so on; he knows, or believes he knows, exactly what the factory pays for sweeping floors, carting ashes, and oiling shafting, and aims at minute exactitude in all records of indirect expenditure. This inevitably leads to a close scrutiny of every item of this class, thus enabling the manager to decide readily on changes of methods or men; it also leads directly to the view that all such items

of indirect expenditure as are devoted to permanent betterments of buildings, tools, or plant generally, go towards the reduction of the cost of merchantable product, and hence should be credited as assets, either wholly or in part, although, as previously pointed out, there is no possible way in which these items can be made directly to return the cash which they cost. They are of value to the going concern only, and do not bring anything at forced sales.

But the modern factory accountant must of necessity have a judicial mind and also an active conscience. He must be able to perceive clearly the whole result of his indirect expenditures, and he must apportion his charges correctly according to these effects. These needful qualifications of the good factory accountant lead, in many cases, to really exasperating shadings and divisions of indirect expense, often involving much clerical labor, and particularly obnoxious and aggravating to subordinates who lack the wide view and high sense of justice and quick conscience of the superior accountant who installs the system.

The subordinate says: "Why is all this unending labor of useless hair-splitting added to the really useful part of my work? Why must I be always on the outlook for the prescribed final disposition of these small and trifling items, which might just as well go bodily into the general expense and be done with it, as be split up on some fanciful scheme of percentages and charged into some of these minor divided accounts, none of which can ever be returned in direct cash?"

From the standpoint of the subordinate his complaint is well founded. The chief accountant, is, however, likely to resent such criticism with an intensity of acrimony precisely proportioned to his real breadth of view, sense of justice, and activity of conscience. Hence the chief accountant says: "The object of our whole accounting system is to group allied items of expenditure finally under headings which correctly represent the ultimate results of such expenditures. True, the money has gone, and will never be returned in direct form. Part of this money has been so expended that it has no future earning powers; part of it has been so placed that it has large and valuable future earning powers. I might as well throw away the whole system as fail to recognize these differences in results."

Consequently the chief accountant commands the subordinate to follow the system, and the subordinate obeys under strong mental protest, and a condition of high frictional resistance is established and maintained permanently, much to the detriment of the comfort and efficiency of all concerned.

This is no merely fanciful supposition. In one of the largest and best of American machine-tool factories a cost-system was, and probably still is, in use which involved a large number of minor divided expense accounts. This system was installed by one of the chief owners, a man of naturally high abilities, with great breadth of view and keen sense of justice, who has given a vast amount of consideration to factory accounting, has traveled extensively both in Europe and the United States, and is familiar with both the general theory of factory accounting and the particular systems adopted in many establishments of high repute. Yet the cost-keeper of this large establishment, who with seven assistants found it difficult to gather and separate the items of expenditure according to the system installed, had no hesitation in saying with bitter emphasis that all this unremitting labor of cost-keeping brought in absolutely no valuable return, and that in his opinion, in view of the constant friction caused by the exercise of autocratic authority necessary to carrying out the details of the cost gathering, the factory would actually be better in every way if the whole cost-keeping system was thrown out of the door.

In this case at least, it was clearly evident that, however valuable detailed information as to minor expenditure items may be to the manager, there is yet a limit to the subdivision of accounting beyond which it is highly undesirable to go.

Probably there will always be very wide margins of difference between the methods of really successful factory accountants, in this particular of the final disposition to be made of indirect expense items. There is always the choice to be made between the view that regards closed doors and forced sales as a possible finality, and the view that holds the factory to be a vital individual existence, with probabilities of immortality. In point of fact, factories begin, run their course of natural life, and die, like all other creatures; so much is certain from the daily record of current events.

Some factory accountants will hold to the theory that their business is to deal with going concerns, and that the factory with closed doors, dead and gone forever, is not a profitable subject of consideration. These accountants will carry a greater or less proportion of the indirect expense into accounts showing as assets. Other factory accountants, taking heed to the fate of all human enterprises, will have closed doors always in their mental view, and will write directly into the expense account all outlays which cannot reasonably be expected to return in cash or bankable paper, with no saving clause whatever as to future earning possibilities.

THE REGULATION OF THE YELLOW RIVER IN CHINA.

By William Starling.



Native Chinese River Boats.

WITH the exception of one tract, China is a mountainous country, though with countless fine river-valleys and plains. The general profile of the region is an immense slope, from the great table-land of Thibet to the sea, interrupted, in the northern part, by the Great Plain.

There are at least three well defined mountain systems in eastern Asia; the Tien-shan, the Kwen-lun and the Sinian. The first is not found south of the Gobi basin, though it projects its spurs far into it; the second runs in a nearly east-and-west direction; and the third stretches from south-west to north-east, beyond the limits of the Chinese Empire.

North of the Great Wall and stretching far to the west, even to the base of the Pamir uplands, lies a vast undrained tract similar in most of its features to the Great Basin of the United States. It is bounded on all sides by mountains. The rivers which rise within it have no exit from it. The basin is what an American would call an alkali plain. It is flat, sandy, and with a very scanty growth, due to an arid climate. It is called by the Chinese the "Dry Sea." It is usually denominated the great Desert of Gobi.

By some circumstances of which we are not apprised, gaps were opened in the margin of the basin and some streams found drainage for themselves. The dimensions of the basin were correspondingly reduced. Consequently, surrounding the Gobi basin proper there is what has been called a transition region, which partakes of the desert character and had evidently a common origin with the basin, yet does not drain into it.

In the engineering activity which is certain to follow the restoration of order in China, river improvement will play no inconsiderable part. Transport requirements alone would bring about this result, for nowhere in the world, perhaps, are waterways more depended upon, even to the exclusion of the roads. But beyond that, the great rivers which have been the cause of so much disaster in the past must be brought under control. The largest of these problems is taken by Mr. Starling as his theme.—THE EDITORS.

South of the desert, in one of the many ranges of the Kwen-lun, in the northeastern part of Thibet, the Yellow River rises, in a wide valley, dotted over with eight or nine lakes, great and small, and called, from this circumstance, the Sea of Stars. From this region the river makes its way, receiving many accessions from mountain streams, through and around the parallel ridges of the Kwen-lun system.

After escaping from the mountains, at a distance from the source of about 700 miles, the Yellow River pursues a career varied and tortuous to an extent which has few counterparts among rivers. First through the foot-hills and the steppe-land forming the periphery of the Gobi basin to a distance of perhaps 500 miles; thence turning nearly at right angles to the east through the country of the Ordos for some 130 miles more; then another right angle, and through the high plateaus of Shen-si and Shan-si to the south, where, so to speak, it is brought up with a round turn by the granites and crystallines of the eastern extension of the Kwen-lun Mountains, whence it started 1,700 miles higher, and forced into a course which is more acute than a right angle to its former direction.



HOUSE BOATS AT SU CHAU.

The Ordos country belongs to the transition region of which mention has been made. It is a part of the desert in all but the drainage. The basin of the river here is very narrow. Through the mountain country it had been well watered, but here it receives no tributaries and probably loses a portion of its volume.

As the river progresses eastward toward the highlands which bound the desert country, the condition improves. The rainfall is greater and the river receives a larger proportion of it. At the second right angle mentioned above, where the river turns south, it is fairly within the mountain region, and has entered upon that part of its



CHINESE WATERWAYS. SU CHAU CREEK.

course which is to decide its destiny. It is in China proper, and forms the boundary between the important provinces of Shan-si and Shen-si.

These are mountain districts, formed by ranges of the Sinian system. They are cut in two by the Kwen-lun axis in the south of Shen-si and in Ho-nan, where the ranges of the latter system form the right bank of the Yellow River.

The mountains of Shan-si form an elevated ridge dividing the valley of the Yellow River from the great plain. At the eastern base of the mountains lies Peking. Everything to the east of the watershed flows into the Pei-ho system.

The mountainous region of Shan-si and Shen-si, through which the Yellow River now runs, is a plateau composed of nearly horizontal carboniferous strata, superposed upon older rocks and overlain on their flanks by heavy deposits of loess.

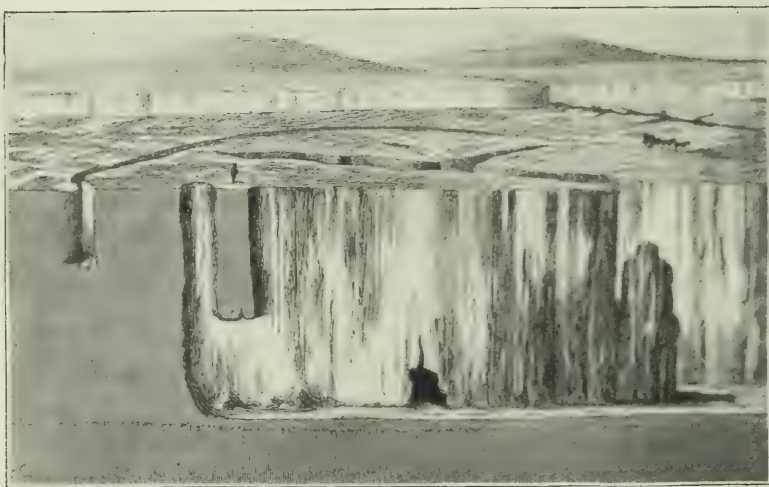
Loess is a material which is very widely distributed over the earth, and which by its peculiarities excites attention and is easily recognized wherever it is found. It was first observed on the Rhine: then, prob-



A LOESS LANDSCAPE. FROM RICHTHOFEN.

ably, in America; and finally it was noticed, in 1862, by Mr. Pumpelly, in China. It has, in that country, been made the subject of special study by the eminent traveler and geologist, Baron von Richthofen, and a theory of its origin has been evolved by him which has been much discussed, and finally, so far as the Chinese formation is concerned, has been generally accepted.

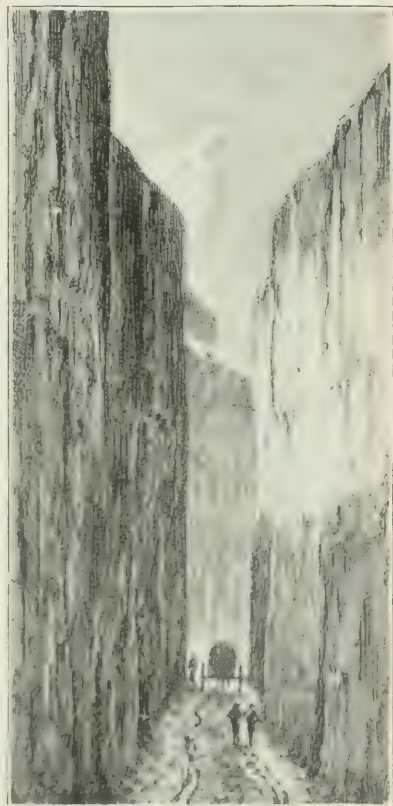
Loess, wherever found, is a yellowish, brownish, or grayish earth which is so soft and friable that it is easily reduced to powder between the fingers, and yet of so firm a consistency that when undermined by currents of water or other disturbing influences it will stand in per-



SIDE WALL IN A LOESS RAVINE, WITH SMALL CAÑONS. FROM RICHTHOFEN.

pendicular walls several hundred feet high. The cuts given herewith (taken from Richthofen's China) give interesting examples of this peculiarity. The particles composing the earth have been, by some process, reduced to such a minute state of division that it is asserted that they can be rubbed into the pores of the skin and disappear, without leaving any considerable residue. It is clayey in appearance, owing to the extreme fineness of its particles, yet when closely examined it is found to consist mostly of sand, which has very little appearance of having been subjected to attrition, but is sharp and angular. There is a considerable proportion of lime in it, which furnishes the cement necessary to hold it together. It is very susceptible to the attack of currents; and while it is said that it soon subsides from still water, it is carried long distances by streams.

Loess is very common in the Mississippi valley, being found from Pierre in South Dakota to Baton Rouge on the Mississippi. It forms the bluffs of Council Bluffs, Quincy, and other localities on the upper river, and of Memphis, Vicksburg, and sundry other points on the lower. In America and in Europe its utmost thickness is 100 or 200 feet, but in China it has a development of ten times that much.



SUNKEN ROAD IN THE LOESS.
FROM RICHTHOFFEN.

The Sinian mountain system of China has been compared to the Appalachian system of America.* Certainly the Carboniferous plateau of Shan-si and Shen-si bears a strong resemblance to the Cumberland plateau, and still more likeness to the Ozark plateau of Missouri and Arkansas. The loess, in China, does not cap the highest eminences, but rests against the flanks of the older strata. The highest parts of the plateau of Shan-si stand about 7,500 feet

* Pumpelly, *Geological Researches in China, etc.*, Washington, 1867, p. 68.

above the sea, though generally the elevation does not exceed 5,000.* The loess is found at all heights from 400 feet to more than 7,000 feet. The thickness is thought to reach 2,000 feet in places. It is very commonly as much as 1,000. It does not by any means cover the whole mountain region of the two provinces named. On the immediate



A LOESS VILLAGE. FROM RICHTHOFEN.

banks of the Hwang-ho it is conspicuously absent. Its greatest development is along the tributaries, especially the Fonn-ho.

Where the loess formation is predominant it impresses very remarkable features upon the landscape and even upon the life of the population. Its characteristic property of standing vertically is everywhere displayed. Roads are soon worn into the earth, the walls on either side still retaining their perpendicular, till in the course of years there is formed a sunken road perhaps 70 or 80 feet beneath the level of the plateau. Often there are successive cuts which are transformed into terraces, and houses or villages built upon them after the manner of cliff dwellings. Indeed, chambers are frequently excavated deep into the walls, and even whole suites of rooms. In fact, as Richthofen says, the dwellings vary from simple caves to veritable loess palaces.

Similar things occur in the loess districts of the United States. Near Natchez, in Mississippi, and no doubt at plenty of other places,

* Richthofen, China, Vol. I., p. 73, and sections on p. 58.

where the loess formation prevails, sunken roads may be seen, 20 feet or more in depth, with vertical sides. During the siege of Vicksburg the people dug themselves bomb-proof shelters in the loess. In Nebraska and Kansas "dug-outs" in the same kind of soil are not, or were not, uncommon.

The passage of the Yellow River through the Sinian plateau is a veritable cañon, some two miles wide and 1,500 feet deep, deeply incised in the Subcarboniferous limestones, and without even a strip of bottom land. Here the river receives large additions to its volume, both of water and of sediment, through numerous and powerful tributaries, which enter from both sides, but especially from the west. The headwaters of these streams are divided only by a narrow watershed from the tributaries of the Yellow River in its first upper course to the north, in the Kwen-lun Mountains.



LOESS LANDSCAPE. FROM RICHTHOFFEN.

The principal tributaries in Shen-si and Shan-si are the Fonn-ho, the Lo-ho and the Wei-ho. These are rapid mountain streams, with numerous smaller affluents, all running through loess districts. Neither they nor the Yellow River itself are navigable in this part of their course. Below the mouth of the Fonn-ho the hard rocks which

have hitherto formed the banks of the main stream give way to loess, and henceforth this or the alluvium is the surface formation, except where the river has cut through the superficial mantle and has made its bed in the harder underlying Paleozoic or Archean rocks.

The great bend alluded to is caused by the massive granite range of the Kwen-lun stretching across the path of the Hwang-ho and deflecting the latter sharply to the east, to send it, in 145 miles more, into the great plain. At the foot of the bend the fortress of Tung-kwan uprears itself on the top of a high loess terrace, and a little to the west is the high granite hill of Ta-hwa-shan with its temple.* Here the



LOESS WALL ON THE YELLOW RIVER, NEAR THE BEGINNING OF THE DIKE SYSTEM.
FROM RICHTHOFEN.

river receives the largest of its affluents, the Wei-ho. In spite of the rocky walls which line the sides of its greater valley, the actual banks of the river consist of loess precipices: on the left 200 feet high, on the right 800 feet. Till the river makes its exit from the mountains, high loess walls rise from the water's edge, sometimes on the one bank, sometimes on the other, while on the opposite side there is often a strip of alluvial bottom. Here and there the stream is closely hemmed in on both sides, as at Tung-kwan. The current is always swift. Often the stream is divided by sand bars into two or more channels. Sometimes the bed is composed of rock or gravel. The Yellow River, in this

* Richthofen, China, Vol. II., pp. 546 and following.



ON THE UPPER YANGTSE-KIANG.

stretch, or indeed in the whole mountain region, is not fit for navigation. In fact, it is not navigable except for the smallest kind of boats till it reaches the point where the new course branches off, since the break of 1852, some 20 miles east of Kai-fong-fu.

For 60 miles or so after leaving the mountains the right bank is bounded by high loess bluffs, of which a sketch is given, taken from Richthofen. On the left is a tract of sandy overflowed land reaching



RAFT ON THE UPPER YANGTSE-KIANG.

to the foot of the mountains of Shan-si, 15 or 20 miles distant. Beyond this strip, and on the zone of rich detritus brought down by the washings of the mountains, lies the famous Hwai-king tract, the Garden of China.* The Great Plain is a roughly-trapezoidal area, lying between the mountains and the sea, extending from about the 30th to the 40th degree of latitude, or nearly 700 miles, in length, and in breadth from 100 to 500 miles. It is partly interrupted, on the sea side, by the mountainous peninsula of Shan-tung, and the southern end has a ragged and irregular outline, caused by the projection into the plain of several spurs of the highlands south of the Yang-tse-kiang. Into this plain, near its middle, about the 35th parallel, the Yellow River debouches. There are two possible routes by which it may reach the ocean, north of the promontory of Shan-tung or south of it. It has occupied both of these in not very remote times. Up to A. D. 1194 it flowed north of Shan-tung, occupying, in a general way, what is now the bed of the Wei-ho (not the mountain tributary of the Yellow River of that name, but a tributary of the Pei-ho). In 1194



SHIPPING ON THE SHANGHAI RIVER

the river deserted this bed and elected to take the southerly course, emptying into the Yellow Sea about the 34th parallel. It followed this direction till about 1852, when it turned again to the north-east.

* Richthofen, China, Vol. II., p. 521.

This revolutionary movement on the part of the river was not known outside of China for nearly twenty years, and the cause of it is merely matter of inference.



NING PO STEAMER

For the upper course of the Yellow River, from its source to the point where it enters the Great Plain, pretty much all the information we have is derived from Richthofen. From his text, cross-sections, and maps we are enabled to get a fair idea of the mountain part of the Hwang-ho. For the Lower River, as it will be called for convenience, we have more numerous sources of intelligence. Several intelligent travelers have visited different sections of the river, among them four experienced engineers, and some instrumental determinations of value have been made. The latest additions to our knowledge have been made by two Dutch explorers, Captain Van Schermbeek, of the Royal Dutch Engineers, and Mr. Visser, a member of a well-known contracting firm, who were sent out by the Society for the Promotion of Dutch Engineering Works Abroad, in 1889, for the express purpose of securing accurate information about the Yellow River and ascertaining its capacity for improvement. Their report was printed in 1891,* with a prefatory memoir by the distinguished engineer, Mr. Fijnje, and the whole volume contains a vast deal of

* Memorandum relative to the Improvement of the Hwang-ho or Yellow River in North China, by J. G. W. Fijnje van Salverda, and Report of Captain P. G. Van Schermbeek, Royal Dutch Engineers, and A. Visser, on their Inspection of the Yellow River and Its Flooded Districts in 1889. The Hague, 1891. Privately printed.

Of this valuable publication unfortunately only 200 copies were printed. The writer is indebted for his copy to the kindness of Mr. Fijnje.



BAMBOO POLE BOAT ON A CHINESE RIVER.

valuable information on the subject of the Yellow River and of river improvement generally. To these gentlemen, to Mr. Morrison, and to General Wilson we owe pretty much all the precise information we have about this interesting and perplexing stream.

The Hwang-ho is not one of the great rivers of the world, as is sufficiently shown by its name. We are told that the word *ho* is not applied to rivers of the first class, the name *kiang* being reserved for them. Its drainage basin is said to have an area of about 475,000 square miles,* of which a considerable part lies in the desert. Its length is estimated by Mr. Fijnje as about 3,760 kilometres (say 2,330 miles), or probably more. General Wilson compares it, where it was seen by him, in respect of color, volume of water, and even the character and appearance of its foreshores, to the Missouri above Bismarck. It was less than 1,400 feet wide, in the average, with low banks and a shallow channel. Where it was seen by Captain Van Schermbeek and Mr. Visser it was of very irregular width and depth, the sectional area being something like 9,000 square feet at a rather low stage. The plains are almost perfectly level, and stretch away for hundreds of miles without the slightest rise or depression.†

The Yellow River bears a general resemblance to the Missouri in some respects, while in others it is more like the Arkansas. It is

* Wilson, China, p. 36.

† Wilson, China, p. 35.

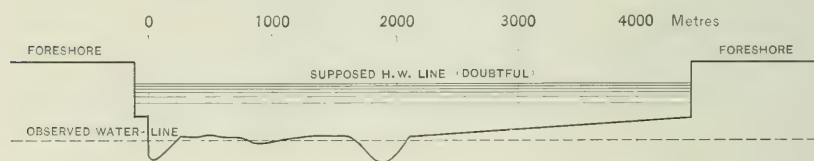
distinguished, however, from the American rivers, if not, indeed, from all known streams, by the character of the deposits through which it flows previously to entering its alluvial plain, and the tremendous change undergone by its slope and velocity in making the transition from a mountain to a lowland career. There is nothing ever yet observed, or at least reported, that compares with the thickness and abundance of the loess deposits of Shan-si, Shen-si, and Ho-nan. The nearest approach to it is found in the Bad Lands of the Dakotas. In the latter instance, however, the material is less erodable, its thickness and extent are less, and the slopes of the streams are far inferior. The elevations given by Richthofen were determined by the barometer, and it is not always easy to tell how far above the water the point of observation was situated; but from such data as he gives it would appear that the difference in elevation of the Yellow River, from the great bend or right angle at Tung-kwan to the point of debouchement into the plain, about 145 miles, is about 580 feet, or at the rate of 4 feet to the mile. After entering the plain the slope is somewhat better ascertained. Several instrumental measurements showed the slope of the river in the upper part of its course in the plain to be about one foot to the mile. Nearer the sea, it would seem, from barometrical observations, to be somewhat less, as might be expected.



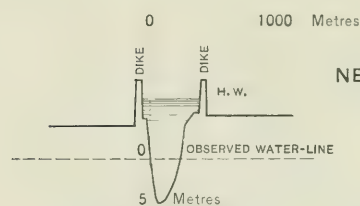
THE HARBOR AT HONG-KONG.

The width of the Yellow River was taken by General Wilson at several points, from Kai-fong-fu down, and found to be 1,500, 983, 1,656, and 1,092 feet, an average of rather more than 1,300 feet. The cross-section was measured by the Dutch engineers at two places, one above the break of 1852, the other below that point. The upper section was very wide, and five-sixths of it were taken up by two immense sand-bars, bare at low water but covered at high stages. On either side of the river was a high foreshore, two miles broad and above high-water mark. It must be remembered that the break of 1852, 20 miles below, had made a radical alteration in the water-level of this part of the stream. The breadth of the river between the foreshores was about 14,300 feet. There were two arms or channels, separated

OLD RIVER - Above Break of 1852.



NEW RIVER - Below Break of 1852.



by a width of sand-bar of about 4,600 feet. The northern arm was 1,340 feet wide, with a mean depth of 3.2 feet and a mean velocity of 2.7 feet; the southern arm was 890 feet wide, with a mean depth of 4.1 feet and a mean velocity of 4.7 feet per second. The total cross-section was about 9,500 square feet, and the total discharge about 31,000 cubic feet per second. The lower section, taken in the new course of the river, about half-way toward the mouth, was fairly regular in shape. It was about 1,080 feet wide and about 10 feet deep. The dikes on the opposite sides of the river were only about 1,700 feet apart. The sectional area was 10,800 square feet, the mean velocity 4.25 feet per second, the discharge 45,500 cubic feet per second. The river had risen in the meantime. The high-water section, as well as it could be determined, was about 44,000 square feet. What the high-

water discharge would be is not so easy to say. Data are scant and formulas tricky. The slope of the Yellow River, in this part of its course, seems to be about the same as that of the Missouri. At Kansas City, in the great flood of 1883, the width of the river was 2,184 feet,



THE WHONG POO RIVER.

the mean depth 27.3, the cross-section 59,500 square feet, the mean velocity 6.2, the discharge 370,000 cubic feet per second. The depth is about the same, the other dimensions greater in the American river. The discharge of the Yellow River probably did not exceed the figure given.

The dikes or levees which border the river do not begin immediately upon its entry into the plain. About 65 miles below the foot of the upland slope the Tsin-ho empties into the Yellow River from the north. The left bank of this stream is the continuation of the detritus slope from the base of the mountains, and is above overflow. Here begin the dikes of the left or northern bank, in about longitude $113^{\circ} 36'$. A few miles below this point (in longitude $113^{\circ} 40'$) the high loess walls on the right bank leave the river, and here the dikes of the right bank begin, resting upon the loess wall.*

The great break of 1852, by which a new direction was given to the river, occurred at a point about 20 miles east of Kai-fong-fu, or 70 miles below the head of the levee system, or 135 miles from the foot of the mountains. Above this point the levees are essentially the same that they have always been. Below it, they are of new construc-

* Memorandum relative to the Improvement of the Hwang-ho, p. 71.

tion. The length of the new line is about 310 miles. The break of 1887 took place about 20 miles above Kai-fong-fu, in the old dike. It was closed on the original line.

Frequently there is a double line of embankment, as is often the case in Europe; one, the main line, being placed at a considerable distance from the river, for security against the erosion of the banks; the other (what the Dutch would call the summer levee) being designed for the protection of the foreshore, which is often extensive and valuable, and sometimes includes cities.

The dimensions of the dikes vary widely. So far as height above flood-level is concerned, the elevation of the water-surface above the break of 1852 has undergone such an alteration by that event that it is difficult to tell what it was. The water level has been much depressed, and the levees now stand very high. Even the foreshores are sometimes above overflow, as we have seen. In the neighborhood of Kai-fong-fu, about 20 miles above the break of 1852, the existing levee is the remnant of a gigantic embankment built by the emperor Kien-lung, more than 100 years ago. This massive work is described as being 40 feet high and 50 feet wide on top, with slopes of 1 on 2. Doubtless, as General Wilson says, it was intended to show how levees ought to be built. It extends only a few miles up the valley, but for a considerable distance along the old abandoned course south of the Shan-tung hills. Below Kai-fong-fu, along the new course of the river, the embankment was found to be from 12 to 14 feet high, with a crown from 20 to 30 feet wide and slopes of 1 on 2. "In many places and for considerable stretches it was well laid out, admirably constructed and in excellent condition, but at others it was not only crooked, but of insufficient height and width, and was in bad condition generally. It was frequently cultivated on the top and sides, cut



SUCHAU CREEK AND BRIDGE.

through by road crossings, and burrowed into by animals. The same may be said of the embankments wherever we come to them."* The dikes, where they were measured by the Dutch engineers, were about 12 feet high and something more than 3 feet above high water. The crown was about 23 feet, the slopes from 1 on 2.5 to 1 on 3. The foreshores were usually high.

The observations of General Wilson in regard to the neglect of the ordinary precautions for the safety of the dikes are yet more emphatically stated by the engineers of the Dutch syndicate. None of the levees is sodded. They saw people engaged in plucking out the last stalks of grass on the slopes for feed for their cattle. The embankments are worn on the outer slopes by erosion and on the inner slopes and crown by wagons, etc.

In short, the levee system of the Yellow River, like many others, is a piece of patchwork, built from time to time, by many administrations, at widely different dates, with great diversities of means and of wisdom. Sometimes the dikes are superfluously high and strong, sometimes they are altogether insufficient. They are always neglected. The river is suffered to get dangerously close to them, by bank erosion, the slopes are not protected by a sward of grass against rains and currents, and they are cut up by travel.

A great deal of care has been taken by all professional observers to ascertain the causes of the different breaks for which the Yellow River has such an unhappy notoriety, and to inquire into the truth or falsity of the often-repeated assertion that the bed of the river has been raised by its own deposits in consequence of the construction of the dikes. There is no evidence in any instance that the breaks were caused by the water of the river running over the tops of the dikes. "The breaches of 1852, 1868, and 1887," say the Dutch engineers, "along the old elevated course of the Hwang-ho, were not caused by overflow of the dikes, but because nothing was done to put a stop to the incessant changes of the channel of the river, till at length it reached the dike and undermined it till it succumbed."† So thinks General Wilson. It is not necessary that the river should actually cut away the levee to cause a break. If it cut into the base of the embankment it may so undermine the foundation of it (which is its weakest part) that the pressure of the external water will literally knock the bottom from under it. This is especially likely to happen in weak soils, and loess is the weakest and most treacherous of all. If we take this into

* Wilson, China, pp. 245-6.

† Memorandum relative to the Improvement of the Hwang-ho, p. 98.

account, the want of sodding and the neglect of proper precautions, we need not look very far for the causes of breaks.

Mr. Morrison found that the bottom of the river near the break of 1887 (which was in the old part of the river, above Kai-fong-fu) was from 3 to 4.5 feet above the natural surface of the adjacent lands. Messrs. Van Schermbeek and Visser agree with him. It is possible then that for the first hundred miles or so after leaving the mountains the river is compelled to lay down a portion of its burden, levees or no levees. When we consider that the river has just been flowing through a mountain country, heavily covered with loess, and with an abundant rainfall in time of high water, at a slope of 4 feet to the mile, and forced to traverse a comparatively flat plain, with a slope of 1 foot to the mile, it is not surprising that it can no longer support the burden of yellow mud to the amount of $1/180$ to $1/270$ of its weight, which it has been carrying. That this condition has been aggravated by the construction of levees is in the highest degree improbable, if not impossible. The building of levees would give greater velocity and transporting power, and would tend to mitigate the evil, though it might not entirely remove it. The trouble seems to be confined to a small part of the river, from the beginning of the levees to the neighborhood of the break of 1852, a distance of, say, 75 miles. Below this point, in the new course which it has been pursuing since 1852, it is evident that the river is engaged in exactly the opposite process from filling up its bed; for it is scouring it out. For many years after it broke through the dikes on the left hand it flowed undisturbed. It was not till 1878 that the new embankments were completed. Between these dikes the river was left to make its own bed. This it has done. General Wilson says, in 1886:

"I found that it had gradually made for itself a new channel, with shores from 5 to 10 feet in height, and that it was otherwise assuming the characteristics throughout that portion of its course which it has above and below."

The remedy proposed by the Dutch engineers is a thorough regularization of the river, at least of the critical part of it, after the manner which they have found successful at home. He would be a sanguine, not to say rash, physician who should prescribe a course of treatment for such a refractory patient without having seen him and carefully studied his case. We may say, however, that the difficulties have been greatly exaggerated, and may agree with those who have seen the river, that its improvement does not present any insuperable obstacles.

THE MEANING OF COMMERCIAL ORGANISATION.

By A. Hamilton Church.

THE development of industrial and particularly of manufacturing operations has been so rapid in the latter half of this century that it is not surprising to find some portions in a state of relative backwardness. This is particularly the case, as indeed might be expected, in those departments in which the actual productive factor does not come into active play, but which are rather concerned with methods of working and with the effecting of adaptations from the old order of things to the new. We have progressed indeed, almost without realising it, from an era in which all mechanical operations were of the simplest character, demanding no very high order of intelligence but merely a certain manipulative skill and craftsmanship, to the present time in which the actual mechanical problems are almost subordinated to questions of co-ordination and of simultaneous production under conditions of imperative exactness and accuracy.

The spectacle afforded by a modern works of the first grade is one of a great series of independent operations, carried on out of sight and for the most part out of knowledge of one another, but so carefully and cunningly devised that their products are in perfect co-ordination. When we contrast this with the machine works of a hundred years ago, in which a "mechanic" was one who exercised all branches of a craft, to-day split up into almost numberless separate pursuits or callings, the truth is realised that this ancient condition of things not only no longer exists but has no possible parallel in our day.

To the toilsome and uncertain progress of the "base mechanic" of our polite forefathers came the enlightening spark of genius from the brains of a host of great mechanicians, transferring the area of possible triumphs from the merely manipulative to the mental field. It became no longer a question of a single device painfully wrought into shape by almost unassisted hand labour, but of the coming of machines which were of themselves producers, and far more accurate producers than the most skilful craftsman ever was.

The advent of the machine tool, with its endless reproductive powers, with its yet unexhausted possibilities in the way of division of

Mr. Church, the associate of Mr. J. Slater Lewis, is one of the leaders of the new science of modern manufacturing. The strong feature of his article is his demonstration that organisation is an integral and even basal part of successful works management—not merely an auxiliary to it.—THE EDITORS.

labour, and its infinitely greater accuracy and power, was bound to revolutionise and transform the operations on which it could be directed. But this of itself is perhaps the least important of the changes differentiating the old from the new order. Close on the heels of the machine tool came the necessity for an altogether higher type of intelligence to control the increasing complexity of industrial operations. The "mechanic" disappears; in his place we have the "captain of industry," with his keen intelligence fully awake to the interaction of complex forces whose field is the whole world; he requires the capacity not merely to manipulate iron and steel, but—a much rarer gift—to understand men of many capacities and of a number of different social grades. To-day, indeed, the manufacturer might be said without much exaggeration to be the pivot on which society at large revolves. On his training, his intelligence, and his fitness for his life-work depend the future and destiny of nations. So true is this that it is almost a truism, recognised publicly by the frantic rush for technical education or whatever other panacea is fashionable at the moment for spreading the glamour of hope over the cruel statistics of diminishing or non-progressive trade.

The most progressive manufacturer is bound and limited, however, by the environment in which he finds himself. If it is true that industry is undergoing a process of change which is as yet far from finality, it is still more true that the process has many currents, and that it is impossible to master and turn all of them to account by a sudden effort, or by partial measures of reform. The older and the larger the undertaking, the more cautious we must be in making changes and the more resolute not to be satisfied with a fractional success. In an old organism the roots are deep, and their ramifications are not at all on the surface. Even in the interior arrangements of great factories there are vested interests that the most despotic reformer will hesitate to disturb, preferring to undermine than to carry by assault. What a writer in *THE ENGINEERING MAGAZINE* has well termed the "departmental ogre" has to be reckoned with, and it is a matter of intelligence rather than strength to do so.

All these considerations tend, as it happens, to one and the same result. Reform begins and generally ends with the modernising of machinery and non-productive appliances in that department, such as cranes, shop-transport, tool-rooms, and the like, leaving untouched the system of nerves, by which the whole is directed, and the importance of which has been recently brought into the light of day by the appearance of Mr. Slater Lewis's great work, under the title of *Commercial*

Organisation. The general effect of leaving this important section out of account is much the same as that of trying to restore life to a dying man by mounting him on a bicycle, instead of by building up the decaying tissues first.

Small wonder it is that drastic re-organisations often fail to give relief. Co-ordination is the keynote of modern industry, but it is a word of which the meaning is too often ignored by would-be reformers. Add that co-ordination is the very antithesis, the irreconcilable opposite, of rule of thumb, and we see the reason why the introduction of modern appliances does not always spell commercial salvation, but may even hasten the day of disaster. Congestion of work, dislocating the even flow of output, is no rare phenomenon; but it is getting to be a more and more inexcusable one, in so far as it does not arise from a sudden and unforeseen press of business.

Nothing is less elastic than the commercial organisation of a large place of business. Nothing clings more closely to tradition. The lines by which communication between the various departments is effected tend to wear ruts, out of which it is not permissible to jump. There is no remedy for this. The system will never be devised that will change with new conditions of the work it has to perform. The case of our government departments is a notorious example of systems once and temporarily good which have been left to harden and petrify. Most old businesses show on examination a similar state of results. As it is in the nature of things that this should be so, we can only look to the remedy, and no deeper. The remedy is to be continually on guard, and to bring the whole question under review when it is known that new factors have entered into actual practice. That this condition exists in most engineering concerns is evident enough.

From a practical point of view it may be said that as co-ordination is the imperative need of to-day, the nerve system must be re-arranged with that end kept steadily in view. The object of the commercial, or, as it might also be termed, the administrative organisation scheme, should be to collect knowledge of what is going forward, not merely qualitatively, but quantitatively; it should also provide the means of regulating as well as the means of recording. It is no mere matter of accountancy, although the element of cost is an important factor. Nor is the matter merely a technical one. It is essentially a matter of administrative control that is in question, stretching through every department and regulating the healthy life of the whole.

Having thus generally outlined the meaning of commercial or administrative organisation, a definition of its closer application to

practical affairs may be attempted. A common mistake is to assume that there exists any cut-and-dried scheme applicable without thought or trouble to various types of business. The fallacy has arisen in the confounding of book-keeping with organisation. Epigrammatically it may be said that there is some book-keeping in organisation, but that there is no organisation in book-keeping.

Local conditions will always demand the first consideration. With a good system as a basis, modifications may be arranged to suit these; but the operation is a dangerous one for amateur exercise. The reason is obvious. In a well-ordered system there are far-reaching tentacles, complex interlockings, disturbance of which may vitiate a good deal of the value of the new results. But the greatest danger is that a partial solution only is reached where a complete one lies within grasp. More especially must it be emphasised that a knowledge of what is termed prime cost is no evidence of an intelligent control of the commercial side of a manufacturing business. It is true that some small businesses manage to rub along without even this elementary attempt at systemising, but the majority of firms of any size have some sort of cost method, however rough and home-made, which enables them to tell how much labour and what value of material have been expended on **any** particular job. Between this elementary stage and the next there is a very wide gap, which is bridged over by comparatively few firms, even in the go-ahead United States. The analysis of the working indirect expenses of the business, and in particular the discrimination between "works expense"—that is, the expenditure on productive departments—and "general establishment expenditure"—representing the expenses of the selling organisation—is a principle the fundamental importance of which had only dimly been realised by the book-keeping mind, and was first given the prominence due to its importance in the Slater Lewis system.

There is yet another stage before finality is reached. When once the distinction has been pointed out, it is obviously not enough to know the mere prime cost of work, without taking into account the indirect expenditure of the particular shop or department in which such work is carried out. One job may cost exactly the same in labour and materials as another job, and yet be quite unremunerative if taken at the same price; for one may be made under totally different conditions, and in itself may be an entirely different class of product from the other; yet this difference is in no-wise reflected in the prime-cost accounts. The item "labour," for instance, may be representative of a large amount of cheap labour or a small amount of highly-skilled

labour, with a totally different incidence of indirect expense in either case. This is, to a large extent, set right by the above-mentioned analysis of works expenditure by departments, so that work done in one shop may be burdened more heavily with such indirect expenses than work done in another shop. But even when this is done, and when the local conditions peculiar to each department have been fully ascertained and means for the due reflection of this factor in the costs have been arranged, there still remains the problem of the department which, as a matter of practical convenience, cannot be divided up, but in which several diverse kinds of work are habitually done. To discriminate between these different classes of work when in the same shop is the third and final stage in the analysis of the statistical information called "costs," and it is the most difficult as it is the most important of all. It is not possible here to do more than refer to the existence of the problem; the discussion of the methods to be adopted for its solution requires separate and very detailed treatment.

The necessity for co-ordination already referred to is an inevitable result of the evolution of the factory. No one mind can grasp and hold all the details. The object of modern administrative organisation is to readjust the balance of responsibilities disturbed by the expansion of industrial operations, and to enable the central control to be restored in its essential features. If we seize this truth firmly we shall be able to criticise intelligently any proposals which may come under discussion, because this and this only is the proper perspective from which to regard all systems of organisation. Hence it will be readily seen that no method fulfills its purpose in which the operations are not immediately known, and their digestion and analysis subject to no delay. It is difficult, unfortunately, to realise the money value of absolute smartness in the presentation of results, until we remember that these results are our only substitute for that keen and active participation of the master's eye and brain in the daily progress of his work which is the life-blood of the small business, and which in the fortunes of industrial progress chiefly assists in its expansion into a large business. How many concerns languish when the care of their founder is withdrawn—and why? Simply because he cannot transfer the multitudinous details of organisation from his memory to that of a successor. It is these details that are essential, and it is their absence that must be fatal unless their place is supplied anew.

Nor must it be forgotten that the introduction of modern organisation is not in any sense the reduction of the subordinate to the rôle of an automatic machine. If it is true that mechanical devices—such

as the comptometer, the slide rule, and the card system—loom very large in the programme, this is because they are labour savers. Now it is not cheap labour that is the chief thing to be saved, but expensive labour. The clerkly drudge with his everlasting copying tends to disappear. But the necessity for intelligence does not tend to disappear. If anything, the trend is in the opposite direction. Fewer people, perhaps, or at least not more people, but people of a higher grade of intelligence. A well-known engineer said to the writer not long since “one of the chief things that hinders British manufacturing enterprise is that they do not get the right grade of people in positions of responsibility. They try to work the thing on a cheap scale. In America the highest types of intelligence find their life work in industrial operations, and—the result is getting pretty evident.”

This indictment is no doubt true. The vast scale of Transatlantic enterprise renders it possible to use higher intelligence, which in Great Britain would be frittered away in so-called “learned professions,” or, still more uselessly, in an amateur political career. And the converse is also true; the vast scale of enterprise is a result of the mental power engaged in industrial operations. In more precise language, the Americans are creating in the industrial arena an environment superior in intelligence and enterprise to that existing elsewhere in the world. Their consequent supremacy is inevitable unless other nations are prepared to tread the same path of reform.

In any system there will remain always a mass of work which is pure mechanical routine. Of this class is computation, and generally all those arithmetical processes which occur in the digestion of each day's operations. Amongst these may be cited: the extension of wages, of material, the computation of establishment charges, aggregation of costs, and all the additions of financial books, such as the sales journals, purchases journals, with their cross-classification totals, and the checking of all classes of returns involving the addition or multiplication of figures. All these operations are much better carried out by an accounting room fitted up with mechanical appliances for the work than by a number of men scattered about the offices and works, each painfully toiling to attain accuracy, and in most cases frequently failing to do so, thereby causing annoyance and confusion at a later date, probably at a most inconvenient moment.

To this extent it may be said that it is proposed to substitute mechanical methods for older ones requiring intelligence. Yet even here the substitution is more apparent than real. The operator of a calculating machine can find plenty of use for an even considerable

quantity of brains, whilst on the other hand the work of say, addition of long columns of figures, or the calculation of numbers of percentages, is drudgery pure and simple, and is usually paid at a low rate.

The most costly thing about a factory is an incomplete organisation. Yet the cost of establishing a good one is often shrunk from like the plague. The reason is particularly obvious where the principals are not their own managers, as in the case of almost all companies. The cost of establishing a new and better system is seen at once in the pay-roll; an additional clerk or a higher salary makes itself clear to the most obtuse board. "Expenses must be kept down," and so the proposal is vetoed. This may, nevertheless, be very far from clever business. The addition of £100 a year is seen, but what is not so clearly seen is the cost of mistakes due to an organisation out-grown. These are smothered. The shops can easily keep their own counsel. The ultimate result of such mistakes, failures of co-ordination, shows, of course, at the year-end in diminished profit in the "Trade a/c." But nobody knows why or wherefore. In the course of a year, several times the cost of a highly-paid staff may easily be muddled away in a large concern, and nobody be a penny the wiser. An incompetent foreman in one single shop, in the absence of proper control, may waste the firm's resources to a perilous extent, and yet the management may be only vaguely conscious that "So-and-So is not as sharp as he might be." The money value of his want of sharpness is an unknown quantity. It ought not to be.

With the growth of competition the necessity for co-ordination and of an accurate and swift presentation of results is more and more imperative. The margin for waste is less, the necessity for detail greater. Everything should be the subject of forecast as to financial results, and of prearrangements as to the actual carrying out. And when it is completed, the records of what did actually take place should be capable of comparison with what was intended to take place. Control then becomes a living reality. Co-ordination implies prevision, of necessity. The place where it pays to spend time and money on work is before it has begun the serious and irrecoverable expenses of production. It is the place, too, where it is most efficiently applied to produce a maximum of smooth working.

To sum up the principles on which a good system should be based and to enumerate the points that it should embrace is not as easy as it may appear, on account of the diversity of the local needs of each special business. With this reservation in view, it may be said that no system is satisfactory and complete in the fullest sense that does

not provide for the immediate serving up of its results, day by day, as they occur, that does not provide in advance for the progress of every piece of work, and that does not present its cost details interlocked with its general and shop establishment charges in such a way as to discriminate: (1), between incidence of indirect shop expenditure and incidence of office and sale-organisation expenditure; (2), between the incidence of shop expenditure in one shop and in another, and (3), between different classes of work in the same shop.

There should also be so close a control over the stores and shops that the present value of assets may be known at least once a month. This implies, as will be obvious to an accountant, that monthly balance-sheets must be furnished, with the advantages which a continuous audit gives. There will also be—what is no less important—a continuous stock-taking. The present state and cost of any order should also be known at any moment, without calculation or more than two references at the most.

With these arrangements should be coupled—in all businesses in which orders have an individuality, *e. g.*, machinery—a method of finding not only the total works cost, including charges, but also the expenses incurred by the individual order after sale, such as commissions, freight, customs duty, workman's out-time and travelling expenses, and the like. The difference between the aggregate of these sums and the sale price is the net profit on that transaction. The sum of all such profits in any period should agree with the profit as declared by the financial books. *Every item of profit, as well as every item of loss, should be traceable by the management, and no covering up allowed.* If these elements are established and intelligently made use of, we have as near approach to the restoration of personal control over the details of a large business as the situation permits.

The catalogue may seem formidable. No doubt a newly commencing business has the advantage in establishing a system of administrative organisation, as it has the advantage of being able to base its productive arrangements on the latest available experience. But if one were to hazard the crystallising of a suitable exhortation to the older type of manufacturer into one sententious phrase, it would run something like this: "Don't be afraid of 'system.' Your present method is a system of some sort, probably an incomplete and bad sort. If it were detailed and described in all its workings it would read quite as formidably as any modern one. Every method requires expenditure to keep it up. A modern system costs less in proportion than an old one, because its results are significant and indispensable."

THE IRON ORES OF BRITISH COLUMBIA.

By H. Mortimer Lamb.

SOME years ago, in a paper read before the Royal Colonial Institute, Dr. G. M. Dawson, then Assistant Director to the Geological Survey of Canada, referring to the large deposits of iron known to exist in British Columbia, remarked that these "wait, to realise their true importance, merely the circumstances which would render their working on a large scale remunerative." That conditions are now favourable for the development of these resources would appear from the interest that is being shown and the enquiry that is being made at the present time, by men intimately associated with the iron industry in the United States, concerning the extensive bodies of magnetite found on Vancouver and the neighbouring islands and mainland.

Although discoveries of large bodies of iron-bearing ores have been made in various localities of the Province at intervals since 1872, no annual production has much exceeded 2,000 tons, and on only one or two occasions has the aggregate output of one year reached that figure. The productive sources have been practically limited to three, or more properly speaking, two mines; one, the Glen Iron Mine, on the line of the Canadian Pacific Railway, at Cherry Bluff, near Kamloops, and the other the Puget Sound Iron Company's properties at Texada Island. In the case of the former the product has been exclusively used for fluxing purposes by the smelters at Tacoma, Revelstoke, and Nelson, while the Texada ore has been shipped to Irondale, Washington Territory, and there smelted with a mixture of from 1-9 to 3-10 of bog ore, making an excellent foundry pig, which was subsequently marketed in San Francisco and utilised, by the Union Iron Works, in the construction of the U. S. war-ships Olympia, Monterey, Charleston, and Oregon. In addition to the two mines mentioned, more or less extensive bodies of iron-bearing ores have been discovered at Sooke, Chemainus, and Barclay Sound on Vancouver

Conditions on the Pacific Coast of America afford one of the most interesting studies now open in the economics of industry. Immediately at hand are vast stores of fuel and iron—the prime elements of all manufacture. Across the Pacific are the enormous new markets of the East, which water transport is bringing nearer every week. Wherever such conditions exist, foci of industry have been created. The dawning century seems likely to witness the birth of new Clevelands, Pittsburgs, Manchesters, in the neighbourhood of Puget Sound. Mr. Lamb's article is essentially a review of some of the material bases of this new world of wealth.—THE EDITORS.

Island; at Rivers and Knight Inlets, on the mainland coast; on the Queen Charlotte Islands, and also in several localities of the inland districts of Similkameen and Cariboo.

The Puget Sound Iron Company's property of 2,700 acres is situated on the south-west side of Texada Island. The ore-mass, which on the surface varies in width from 20 to 25 feet, is an irregular contact deposit between limestone and granite, traceable northward for nearly four miles along a ridge following the coast line, and distant from it a quarter to three-quarters of a mile. Sufficient development work has been done to expose an ore-body estimated by experts as representing 5,000,000 tons of commercially valuable iron in sight. In the course of development, at one point, copper in the form of solid pyrites was found in irregular bunches and stringers in the magnetite, but with increased depth this disappeared. Analyses of the ore have been made on several occasions in the laboratory of the Canadian Geological Survey, one result showing 68.40 per cent. of iron with only .003 per cent. of phosphorus; but a more detailed test gave:

Iron.....	69.85
Manganese.....	trace
Siliceous matter.....	2.75
Sulphur.....	.06
Phosphoric acid.....	trace
Moisture.....	trace

In a report* to the Geological Survey by Mr. Richardson, the geological features of this locality are thus described: "Three miles north-westerly from Gillies Bay, and about seventy paces from the shore, a small exposure of magnetic iron ore was met with, associated with a cross-grained epidotic rock and grey diorite. Immediately north of this exposure the ground rises steeply to about 450 feet above the sea. Here on the eastern and south-eastern slopes of the hill, for about 150 feet down and extending from 200 to 250 feet in length, is an exposure of rich magnetitic iron ore. On the outcrops facing to the north-west the ore-bed is seen to be from 20 to 25 feet thick, and to rest on grey crystalline limestone, with which, for about two feet down, are inter-stratified bands of ore, of from half an inch to one inch in thickness. The hill still rises to the north and north-east, but along the flank, and at about the same elevation, in a north-westerly direction for nearly a mile, the ore is occasionally seen, and in one place there is a continuous exposure of 250 feet. . . . In the concealed intervals the course of the bed appears to be indicated by a coarsely-crystalline epidotic

* Geological Survey, Canada, 1872-3.

rock, carrying ore in places, but with the grey limestones apparently overlying it to the north-east, and the grey and green dioritic rocks beneath it to the south-west. . . . In a north-easterly direction from the first noticed exposure, for a quarter of a mile, no ore is seen, after which it is again found, at first in irregular patches mixed with epidotic rocks and then, its course becoming more northerly, for more than half a mile the bed presents an irregular surface exposure of from 600 to 900 feet of nearly pure ore." Dr. Dawson in commenting on the account given of the occurrence by Mr. Richardson differs from the latter in respect to the nature of the ore-deposit, which he describes as neither a bed nor a true vein, but a contact deposit which has been produced at or near the junction of the granitic mass with the stratified rocks, and more particularly with the limestone. His reasons in support of this opinion are that near the head of the slope, where the ore has been worked, the granitic rocks are replaced by grey crystalline limestone, which occasionally becomes a nearly white marble, and at this contact the large bodies of ore are found, and appear to occupy irregular "chimneys" or interspaces of very variable dimensions. The ore penetrates to some extent not only the granitic rocks, but also the altered volcanic rocks and limestone. It frequently includes large or small epidotic kernels, together with detached fragments of the volcanic rocks, and, in some places, reticulated veins of ore are seen in the granite, forming a species of ore-breccia. The appearances are such as to indicate that the formation of the deposit occurred contemporaneously with the intrusion of the granitic mass and has been dependent on the effects produced by that intrusion, and the appearances developed since work has been carried on are such as to prove that the ore cannot be considered as a bedded deposit.

The second exposure described by Mr. Richardson is doubtless at the head of the present slope and here a shaft was sunk, and at a depth of 150 feet a crosscut driven into the mountain. After passing through dioritic rock for a distance of 187 feet, the ore-body was encountered and proved at this depth to be over a hundred feet in thickness, the ore being remarkably pure, affording 71 per cent. of metallic iron. On the north-east side of the island is a second deposit of magnetite occurring under nearly identical circumstances. The formation containing the iron ore of Texada is believed to be the same as that constituting the greater part of Vancouver and its adjacent islands.

The profitable local manufacture on a large scale of iron from these ores is not altogether a remote contingency, for, as I have previously stated, in a limited way the ore has already been turned to com-

mercial uses on the Pacific coast. Sufficiently cheap labour might be secured by the employment of Orientals, both Chinese and Japanese; an abundant supply of excellent fuel is available in the immediate vicinity; and a permanent market for the product would be assured in the industrial cities of the Pacific sea-board. A further incentive is the bounty granted by the Dominion Government on pig iron manufactured in the country from Canadian ores. On the other hand, supposing that local manufacture is not at present practicable, the coast iron deposits being, without exception, situated within easy access of deep water, transportation costs on the shipment of the crude ore to Puget Sound points would be very light, not exceeding 50 or 60 cents per ton. In addition to this charge, however, the duty of 40 cents per ton on ore imported into the United States must be considered.

On Queen Charlotte Islands clay iron-stones, the nodules varying in weight from a pound to many tons, are of frequent occurrence in the coal rocks, and might be profitably worked in conjunction with the coal seams. Magnetic iron ores of excellent grade also occur in considerable mass on these islands, to the east side of the entrance to Harriet Harbour; while remarkably pure specimens of magnetite containing 71.57 per cent, of metallic iron have been brought from an island in the Walker group.

On the mainland at Rivers Inlet, near the mouth of the Kildella river, an extensive deposit of ore is found outcropping in a contact of granite and limestone, the average of several analyses being 69.5 per cent, of metallic iron and .01 of phosphorus. A deposit, described as a vein 25 feet wide, also occurs on the north shore of West Redonda Island, in the Gulf of Georgia. The ore is a highly magnetic, somewhat finely-crystalline, granular, massive magnetite, an analysis affording the following results: metallic iron, 65.896; phosphorus, none; sulphur, .015. A small shipment of ore was made from this island some years ago, the iron being smelted in Washington Territory and converted into car wheels. Much attention has meanwhile been directed to the iron deposits of Vancouver Island. Of these the most important are the deposits at Barclay Sound, in the Alberni division, on the west coast, and the deposits in the hills to the east of Sooke Harbour, on the south coast, in the Victoria mining division.

The first exposure of iron-bearing ore in the Barclay Sound locality is met with on the mainland about a mile up the Sarita river. Here there is a considerable showing of magnetite in a contact of coarsely-crystalline limestone and diabase. The ore-body, which is said to be 80 feet wide, extends back in an easterly direction a considerable dis-

tance, the exposure having been prospected by the sinking of shallow pits and with crosscuts along its length for 800 feet. The deposit has also been partially explored by means of a tunnel, and solid ore has been encountered at a depth of about 90 feet, 60 feet from the mouth of the tunnel. In a direct line north-west by west, a continuation, apparently, of the same deposit, is exposed both on Copper Island, some two and a half miles distant, and again at Sechart, on the mainland eight miles to the north-west. Mr. Carlisle, formerly provincial mineralogist of British Columbia, examined these deposits in 1897 and described them in his annual report of that year as a ledge of magnetite lying in what appeared to be diorite* and next to a very extensive area of limestone which at the point of contact with the eruptive rock is completely crystallised into large coarse crystals. Both on Copper Island and at Sechart, the ore-body, which has the appearance of being a primary deposit, has been traced for a distance of several thousand yards, the exposures in some places having been scraped clear, giving a width of over 100 feet of magnetite of good quality. Analyses of ore from these localities have been made in England, Pittsburg, and Vancouver, the results being as follows:

	1	2	3	4	5	6
Iron.....	64.00	64.01	66.62	66.60	67.98	69.160
Silica.....	7.35	.....	2.00	.....	2.67	1.500
Alumina.....	0.52	.....	.....	0.14	.....	.....
Sulphur.....	0.0054	0.008	0.02	0.006	trace	trace
Phosphorus.....	0.0071	0.01	0.01	0.003	0.008	0.007
Lime.....	3.76	.....	4.00	...	3.000	0.250
Manganese.....	trace	.....	.....	.....	0.250	0.160
Magnesia.....	.....	.....	.....	.....	1.150	0.120

In passing it may prove interesting to state that the rare mineral ilvaite has been discovered at the head of Barclay Sound, occurring in large irregular masses in a vein about 20 feet wide, an analysis affording the following results:

Silica.....	29.81
Alumina.....	0.16
Ferric Oxide.....	18.89
Ferrous Oxide.....	32.50
Manganous Oxide.....	2.22
Lime.....	13.82
Magnesia.....	0.30
Water.....	1.62

99.32

Up to the present time the iron areas have been held by men un-

* This is a mistake; the rock is a diabase.

able, through lack of the necessary means, to develop them; but recently the properties in all three localities were acquired under option by capitalists of Pennsylvania, who have commenced systematic exploration and development. If these result satisfactorily the ores can be quarried out, it is stated, at a cost of about 20 cents per ton and delivered on board steel scows for an additional 30 cents or less.

The magnetic iron ores at Sooke Harbour are somewhat similar in character to those of Texada Island. The deposit, which, according to Dr. Dawson, partakes more of the nature of a stock-work than a true vein, can be distinctly traced in a north-easterly direction for over half a mile, and varies from 15 to 20 feet in width. The country rock is a coarsely-crystalline diorite containing much hornblende. Analysis of the ore made by Dr. Wallace, city analyst of Glasgow, Scotland, shows it to be of fine quality, averaging over 60 per cent. of metallic iron practically free from all impurities. As in the case of the Barclay Sound properties, comparatively little even preliminary work has been done to prove the permanency or extent of the Sooke exposures; but it is stated by an engineer who examined the deposit that the promise of an almost unlimited supply of ore is undoubted, and that with the favourable facilities for working, the ore could be mined and placed on board scows at a maximum cost of \$1.00 per ton. In the same neighbourhood occurs an exposure of hematite, but the deposit is apparently not extensive.

Of the more notable occurrences of iron-bearing ore in the interior of the Province, the most important is the deposit of magnetic iron, known as the Glen Iron Mine, near Kamloops. The mass of the dioritic rock in this locality is much shattered, the cracks and interspaces being filled with the ore, which forms veins of varying degrees of thickness. The ore, which is of excellent quality, containing 66.83 per cent. of metallic iron with very little phosphorus or sulphur, is in some few places mixed to a slight degree with calcite and felspar, but not sufficiently to affect its smelting qualities. The veins, four in number, and running in an easterly and westerly direction, being nearly vertical or dipping north at wide angles, vary from 10 to 20 feet in width, and are traceable on the surface for several hundred feet. Since 1891 the annual production from this mine has been from 500 to 2,000 tons, the ore being mined and conveyed by an aerial tramway to the railway.

In 1888 Dr. Dawson reported a remarkable occurrence of magnetic iron ore about half a mile below the lower falls of the Kootenay River. The ore was found in large loose masses weighing several tons, but owing to the want of good exposure its actual relations to the rocks



APPROACHING COPPER ISLAND.

adjacent were not ascertained. The place of this occurrence is near, if not in, the line of junction of the granites with the here highly-altered rocks of the stratified series. It appeared to be associated with a dyke of green-grey augite-porphyrite and it is probable that the iron



ENTRANCE TO BARCLAY SOUND, COPPER ISLAND IN THE DISTANCE.

ore when *in situ* may form irregular masses along the borders of this dyke. Another noteworthy discovery was made last year by a German geologist, a Mr. Ludloff, in the Cariboo district, of red hematite in a deposit, measuring, so he asserts, 500 feet thick. At present, however, little if any commercial value attaches to discoveries of iron in regions so far remote from railway or other means of communication as that of Fort George, on the Fraser River, the locality in which this occurrence of soft red hematite was discovered by Mr. Ludloff.

At present the extent of information available in respect to the iron deposits of British Columbia has more of a scientific than of a practically commercial interest. As exploration, however, is usually governed by practical considerations, it is probable that those deposits of which anything is known bear but a meagre relation to those of which



GLEN IRON MINE AT CHERRY BLUFF, NEAR KAMLOOPS, B. C.

nothing is as yet definitely ascertainable. It is not too much to say that British Columbia possesses enormous potential resources in her iron deposits, but that these resources must wait for commercial development upon the development of those industries which stimulate a demand for iron. Sooner or later the political reasons which led to the construction of United States battle-ships on the Pacific Coast, for which, as we have seen, British Columbia iron was partially utilised, will give place to commercial



TUNNEL AT THE SARITA MINE, BARCLAY SOUND REGION.

reasons connected with the development of trade on the Pacific necessitating the building of a large mercantile marine. Sooner or later manufacturing industries with their constant demand for the iron which is their base will be brought into being to supply the ever-increasing market of the Orient. When these things happen, British Columbia with its abundant coal and lumber in direct connection with its iron must become the seat of a great iron industry. Meanwhile these resources are chiefly attractive to those who combine in a very rare degree the gift of foresight and indomitable patience.

CENTRAL-STATION PRACTICE IN ENGLAND.

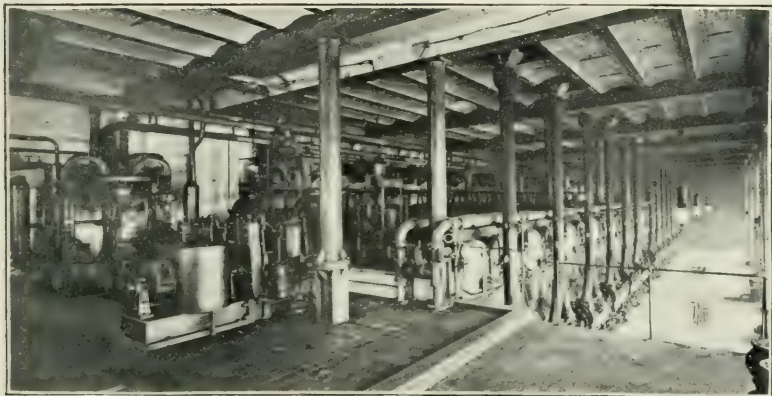
By Frank C. Perkins.

WITH the expanding use of electric power and light, the design and equipment of electric central stations occupies a constantly growing portion of the field of power engineering. International differences, springing from differences in conditions which are in part technical and in part political in their origin, have received much attention. The subject has occupied its share of space in *THE ENGINEERING MAGAZINE*, and not long since typical American practice, so far as the steam end of the plant is concerned, was formulated in these pages by Mr. Hague. By way of illustrating by concrete example what has been in England, this description of the St. Luke's and Wandsworth stations of the County of London Electric Lighting Company is presented.

The site of the St. Luke's station is 303 feet 6 inches along the canal basin of the Regent Canal Company, 165 feet along Graham street parallel to the canal, 140 feet from the canal to Graham street at the northern end, and, being cut diagonally by City Road at the south end, the length along City Road to Graham street is 198 feet 9 inches. It was decided to construct the buildings within what is practically a water-tight tank, formed by thick concrete foundations overlying the whole area of the land and with water- and moisture-proof walls toward the canal, along which a coffer-dam had to be placed by the builders. The buildings, which were designed by the company's architect, Mr. F. Stanley Peach, F. R. I. B. A., in consultation with the company's engineer, are constructed throughout with best selected stock bricks and Portland cement, and the general design, so far as at present finished, is shown in the photographic views herewith.

The chimney is of square cross section with corners cut off. It is 200 feet in height, with a diameter of 12 feet at the top. The engine room is lined with glazed bricks and the floor tiled over with adamant tiles, making a very clean and neat engine room. The switch room is similarly lined with glazed bricks, and has a tiled floor. All floors throughout the building are of concrete on iron joists, the only wood-work being that used for doors and door posts, wood block floors being laid over the concrete, and the boarding for carrying the slates over the engine room.

The boiler room is 198 feet in length by 41 feet in breadth, with space at one end for a double set of economisers, above which there is a short length of flooring upon which the feed pumps are placed, as seen at the left in the illustration. From this to the present extreme north end of the building there are now installed two batteries of six boilers each, with room for a third battery of five boilers. These are fired by automatically-operating stokers, the hoppers of which are supplied with coal through vertical tubes from the coal store above.



ST. LUKE'S STATION BOILER ROOM.

In the pump-room, which is just on a level with the roadway leading off the abutments of the City Road bridge, there are placed two steam feed pumps, capable of supplying 4,000 gallons each against 150 pounds per square inch pressure, as well as two feed pumps driven by electric motors taking power from the continuous-current mains, each also capable of supplying 4,000 gallons or more per hour against the same pressure. There is a large hot-water tank into which the condensed steam from the engines is returned and in which it is freed as much as possible from any cylinder oil which may come along with it, while underneath in the feeder-ring main are two oil filters similar to those generally used on ocean steamers. From this pump-room floor short ladders lead to the platforms from which the screw-down steam valves from the boilers are manipulated. In addition to these screw-down valves, non-return valves are also inserted in the steam pipe of each boiler.

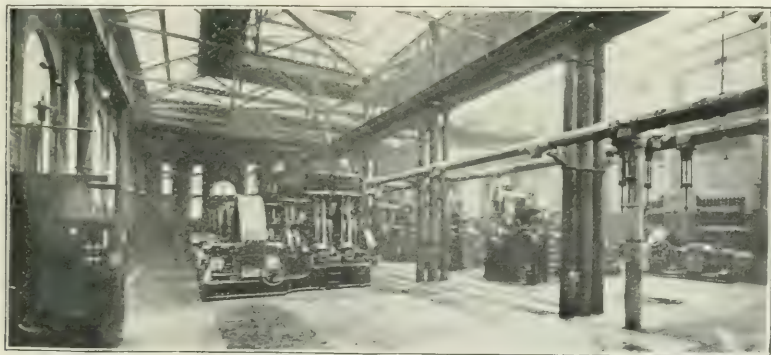
The feed-water valves of each boiler are manipulated by handles on the boiler-room floor, attached to long stems provided with universal joints. The blow-off pipes from the boilers are laid to a tank near a sump, into which any water that may percolate through the concrete

foundations drains, and when cooled in this tank, the blow-off water is lifted at present by means of a steam injector. This, however, is found to be rather wasteful of steam, and it is therefore proposed to replace it with a small motor with automatic switch operated by the rise and fall of the water in the sump.

The large amount of coal used per annum required specially large storage accommodations. The coal-storage room was built over the boiler room, and a pipe is used for conveying the coal to the boilers. To render this portion of the building fire-proof, the flooring is composed of brick arches between iron girders passing from one wall of the boiler room to the other, sheeted over with steel plates. The roof is composed of corrugated iron on steel principals and purlins. Ventilation from the boiler room below is carried out at the back of the coal bunkers by means of a box composed of steel plates, suitably supported from the wall, which carries the heated air from over the boilers and under the coal-store floor out to the roof. Ample ventilation is also provided for the coal bunkers by means of perforated iron pipes. These bunkers are divided longitudinally by a passage-way along which rails are laid, upon which rails an automatic recording weighing machine runs. The machine is so constructed that all coal, even the smallest, must be discharged on each opening of the door; it automatically records the number of times the door has been opened, and this record must correspond with the number of printed tickets of weight handed in by the trimmer at the end of each eight-hours' shift. Into the bunkers on each side (which are divided transversely by steel-plate bulkheads), the coal is conveyed by an automatic conveyor fed from the barges. A powerful hydraulic crane is stationed on the platform abutting on the end of the coal store at the edge of the wharf, the crane being fitted with a grab which, swinging round and falling at a high speed, is dropped onto the fuel in the barge and settles to its charge. The motion being reversed, the grab closes in and shuts fully loaded. The crane slews round while the grab is rising, and on the grab coming over the wrought-iron hopper fitted with spreading sides to prevent fuel splashing over, the releasing gear is operated by the crane man, and the grab deposits its contents in the hopper, which takes the impact of the fuel before it reaches the weighing mechanism. Thence the coal gently slides down into the hopper weighing machine, a self-registering automatic contrivance. The coal then having settled in the hopper, hydraulic pressure is turned on by the mast of the crane when turning round to bring up more coal, and the weighing machine slowly rises, carrying with it a weighing beam of which the outer end presses

against a spring connected with a self-recording dial. The coal being weighed and recorded, the hopper sinks back to its foundation ready for the next charge. Two folding doors operated by hydraulic rams, connected with the exhaust water from the crane, open and allow the coal to drop onto the steel-chain conveyor, which takes the fuel to the stores. As soon as the fuel has all fallen onto the conveyor the folding doors shut, and then the next charge from the grab is delivered. The conveyor is a steel chain running in a cast-iron trough, and travels up an incline from the weighing machine to the two similar conveyors running longitudinally along the coal store at a height of 12 feet from the floor. The storage room will hold 1,000 tons, and 35 tons of coal can be handled per hour. On the same floor there are two large water-storage tanks and a feed-water purifier into which water from the New River Company's mains is fed, for purification prior to storage. These tanks are connected with the feed-water tanks on the pump floor below by means of a straight pipe controlled by an automatic valve, thus providing any make-up water required.

The engine-room girders carry the two 20-ton cranes which convey any piece of machinery to or from the landing stage or its appointed place in the engine room. It was found impossible to utilize the whole



ENGINE AND GENERATOR ROOM, ST. LUKE'S STATION.

space for generating sets, and it was decided to put two landing stages on the road level, the floor of the engine room itself being at the same level as the floor of the stoke room. In the engine room there are two centrifugal pumps driven by steam engines and one motor-driven centrifugal pump for supplying circulating water, which is drawn from the canal at the southern end of the building and discharged at the northern. Close by one of the landing stages are three steam-driven exciters, two of the Electric Construction Company's make and one of the Brush Company's manufacture. There are six 200-kilowatt two-

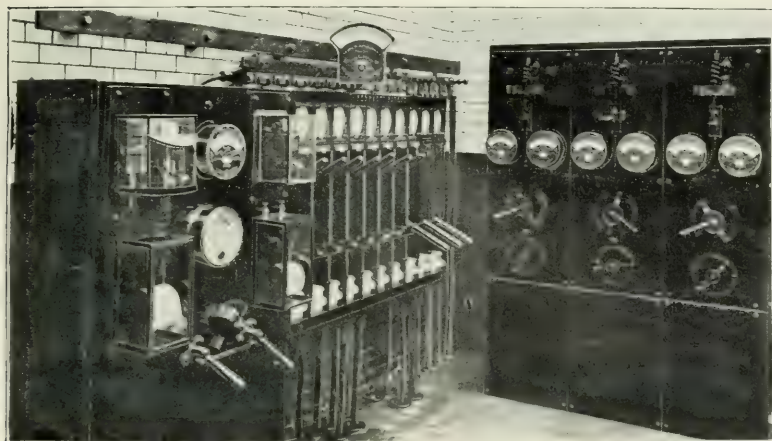
phase generators, 50 periods per second, built by the Electric Construction Company of Wolverhampton.

In the engine room there are five single-phase alternators, of the Brush company's make and of Mordey's well-known design, of 180 kilowatts each, and they can easily carry this load of 90 amperes at 2,000 volts, although originally designed for 150-kilowatt machines. The continuous-current power sets are two cross-compound engines directly coupled to 550-kilowatt generators. In this building there are also two alternating single-phase motor generators, coupled to two 75-kilowatt 530-volt direct-current machines, which have hitherto supplied the direct current for motors throughout the Clerkenwell and St. Luke's Districts. There is also a two-phase motor generator of 50 periods direct-coupled to a direct-current machine of similar voltage and output, shown at the right in the illustration. The steam pipes form a ring in the boiler room and a ring on each side of the central pillars in the engine room and are cross-fed by pipes underneath the floor, so as to have a clear way for any machinery carried by the cranes. The automatic valves are placed on exhaust pipes which run to the top of the chimney, so that the engines may exhaust either to atmosphere or through the condensers. The latter are fitted in the back standards of the engines driving the alternators, each engine being provided with its own air pump, driven by means of a lever off the low-pressure cross-head. Although the speed of these engines is 215 revolutions, a satisfactory vacuum is obtained.

The condensing water is received from the canal and is brought into two large tanks under the roadway between the chimney and City Road. A grating is provided in an aperture of the wall leading from the canal so as to strain the water before it enters the tanks, and each tank is connected with a main pipe leading round to the centrifugal pumps, where both pipes are joined together, and these are provided with suitable valves to shut off one length of pipe from the other. The tanks are also provided with sluices to shut off the water from the canal, so that the tanks may be periodically cleaned out.

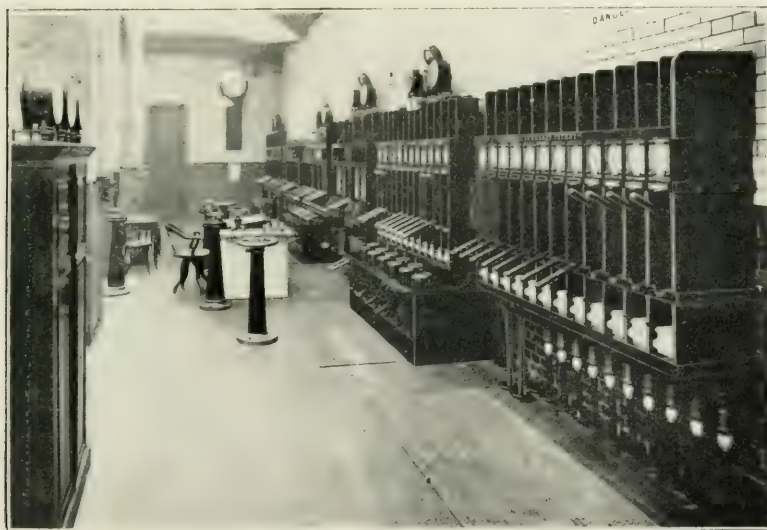
The electric cranes are capable of dealing with loads up to 20 tons in weight. They are not electrically driven because, as a rule, in central stations the principal work of the crane is in assembling the various pieces of machinery, from which a supply of current is not available until after the work of erection is completed.

In the illustration of the engine room may be seen the switchboards for controlling the exciting current from the three main exciters, and the connections of the two small self exciters, attached to two Brush

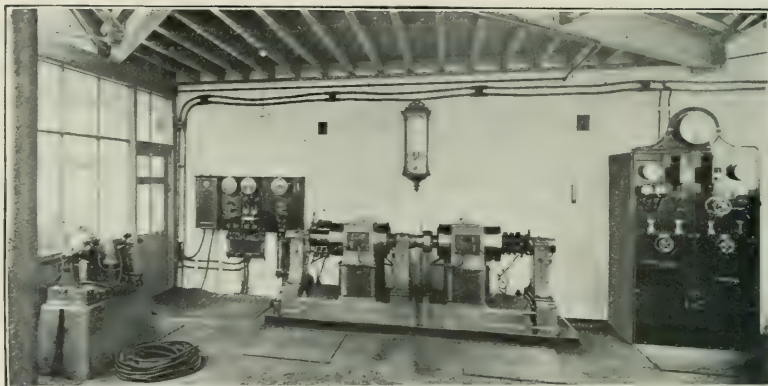


SWITCHBOARD IN ENGINE ROOM, ST. LUKE'S STATION.

machines and with the main current to and from the exciting battery. There are also in the engine room two switchboards for the railway generators. These latter switchboards are connected by cables to the distributing power switchboard, to which are also connected three switch panels, controlling the motor generators, which may be operated either as direct-current machines, taking direct current and supplying alternating current to the mains, or vice-versa. Between these machine switch panels and the circuit panels there is a main measuring



SWITCH ROOM, ST. LUKE'S STATION.



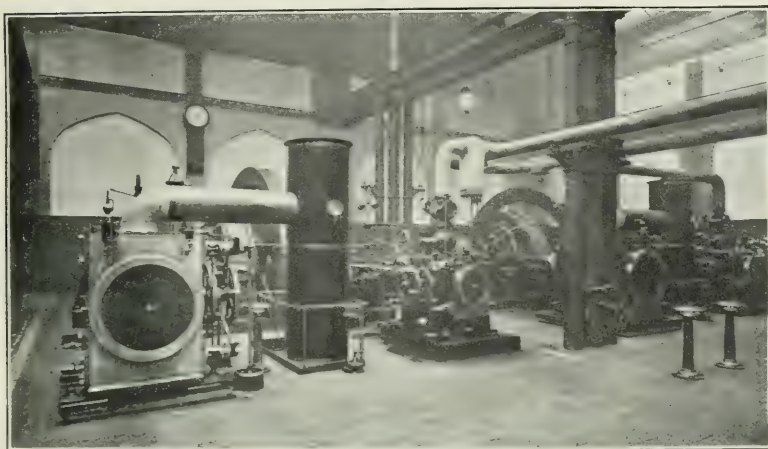
MOTOR GENERATOR AND BOOSTER, ST. LUKE'S STATION

board upon which are mounted ammeters, two Thomson integrating watt meters for light and heavy load, a recording ammeter and recording voltmeter. Beyond this latter board are ten circuit panels of Ferranti's make, also seen in this illustration.

The main alternating-current switchboards are located in the switch room and consist each of twelve switch panels, and between them is the main measuring board, upon which are mounted two sets of measuring machines, one for light and one for heavy current. At present, the board shown on the left is a single-phase board while that to the right is a two-phase board. In the center there are at present placed two instruments for recording the output of each phase of the two-phase plant and two sets of instruments for measuring and recording the output of the heavy and light load of the single-phase



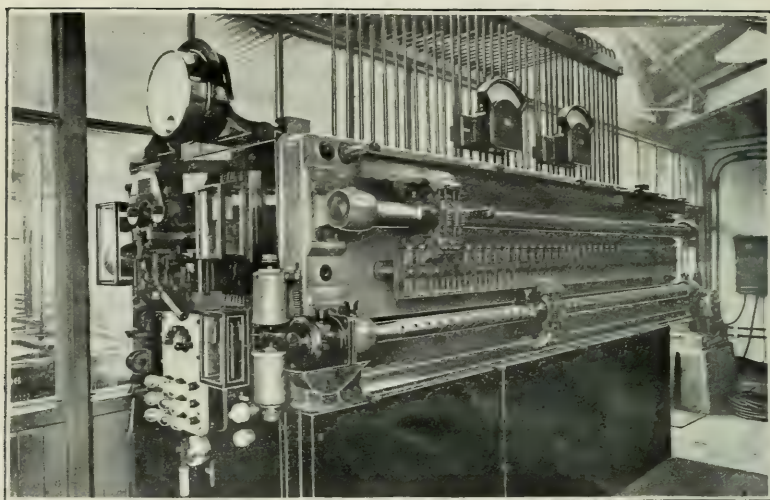
STORAGE-BATTERY ROOM, ST. LUKE'S STATION.



GENERAL ELECTRIC DIRECT-CURRENT GENERATORS AND ALLIS-CORLISS ENGINES
AT ST. LUKE'S STATION.

plant. As soon as all the plant has been changed over to two-phase, both sides can be altered so that they measure and record the output of phases A and B at light and heavy loads respectively. In the background of the illustration of the switch-rooms there are two switchboards of twelve panels each for the single-phase distributing mains, supplying respectively Clerkenwell and St. Luke's. In the foreground at the right may be seen the twelve panels for the two-phase mains which supply current for the districts of Western Holborn and St. Giles. Below each of the alternating switchboards are seen the rheostats in series with the field windings of the main machines, in connection with which there is also an ammeter in each circuit. The regulation of the general voltage of the station is controlled by resistances placed on the regulating table, shown in the front of the main measuring board, and auxiliary regulation is provided by the switch pillars shown at the right and left of the table and in the rear of the switch attendant's table. These switchboards were built by Messrs. S. Z. de Ferranti & Co., while the testing instruments were furnished by Messrs. Elliot Bros.

The storage-battery room is above the landing platforms at the southern end of the building. The battery consists of 302 Tudor accumulators, having a capacity of 595 kilowatt hours, and is run in parallel with the motor generators of some of the railway generators during the day or by itself at night, for the supply of current to motors which may be then running in printing establishments, etc. The illustration on page 414 shows the booster, or motor generator to raise the



MENGARINI AUTOMATIC STORAGE BATTERY REGULATOR, ST. LUKE'S STATION

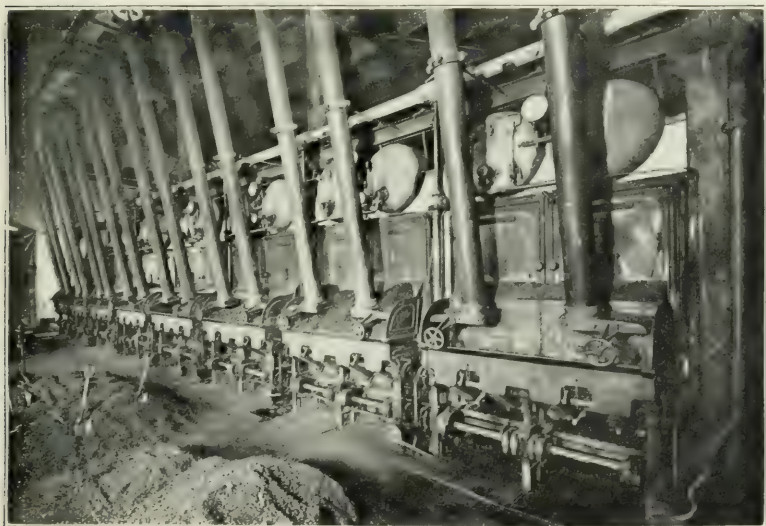
voltage sufficiently for charging, as well as a small milker for any cells which may fall "out of condition."

The switchboard, on which are double sets of terminals for charging and discharging, is provided with an automatic motor-driven arrangement for throwing in or out cells, according as the voltage on the main lines falls below or rises above the normal.

The Wandsworth Station.—Owing to the better shape of the land and the absence of the onerous restrictions imposed upon the company with regard to the St. Luke's building lines, both boiler room and engine room at this station are of more convenient oblong shape with square ends, thus avoiding any waste space as at the northern station. The main buildings are built up of best stock bricks and cement and the engine room and switch room are internally lined with glazed bricks and floored over with adamant tiles. At both stations, to prevent the hum of high-periodicity alternating machinery being too easily conveyed outside, there is an absence of windows in the side walls of the building, the engine rooms being lighted from the roofs. The chimney is 200 feet in height, of hexagon shape and of an internal diameter of 12 feet at the top. With a greater breadth of land than at St. Luke's, it was possible to erect on this site a boiler room 68 feet in width by 110 feet in length (occupying half the available site), in which the plans provided for placing a double row of boilers, their furnace ends projecting inwards, separated by a sufficient distance to allow of the withdrawal of the tubes from any boiler. On each side of

the room there is space for eight boilers with economisers and by-pass flues. One side is now fully occupied, and on the other side the foundations are already prepared for a similar equipment. Along the center space between the boilers and under the floor level, provision is made for ash-conveying gear. The boilers, as at St. Luke's, are fitted with superheaters and automatic stokers. The economisers and scrapers are driven by two small alternating-current motors.

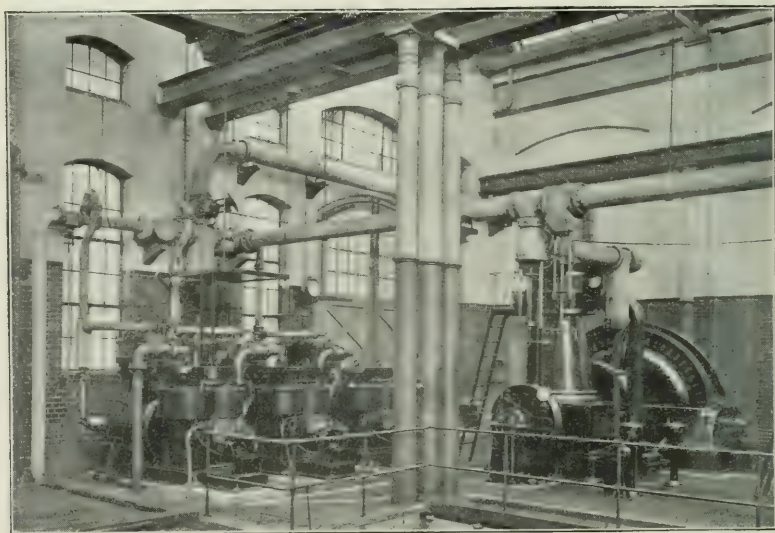
The feed tank is of the same construction as at St. Luke's and the two steam feed pumps, also the same as at St. Luke's, are of 4,000 gallons capacity per hour each, against a pressure of 150 pounds per square inch, but provided with injectors as auxiliaries instead of motor-driven feed pumps. The coal store above is of exactly the same general construction as at St. Luke's, but of course, of larger storage capacity, as it corresponds in size with the boiler room below. The system of coal conveyance from barges to the coal store differs considerably from that adopted at the St. Luke's station, the motive power throughout being that of electricity supplied through two-phase motors of 50 periods at 200 volts; for each line of longitudinal conveyor a separate motor is provided, as well as a separate motor for the diagonal conveyor from the elevator by the weighing hopper to the end of the coal store, and separate motors for the three elevators. The lifting crane is also motor-driven. This crane is fitted, as at St. Luke's, with a grab which takes its charge and discharges its load in a



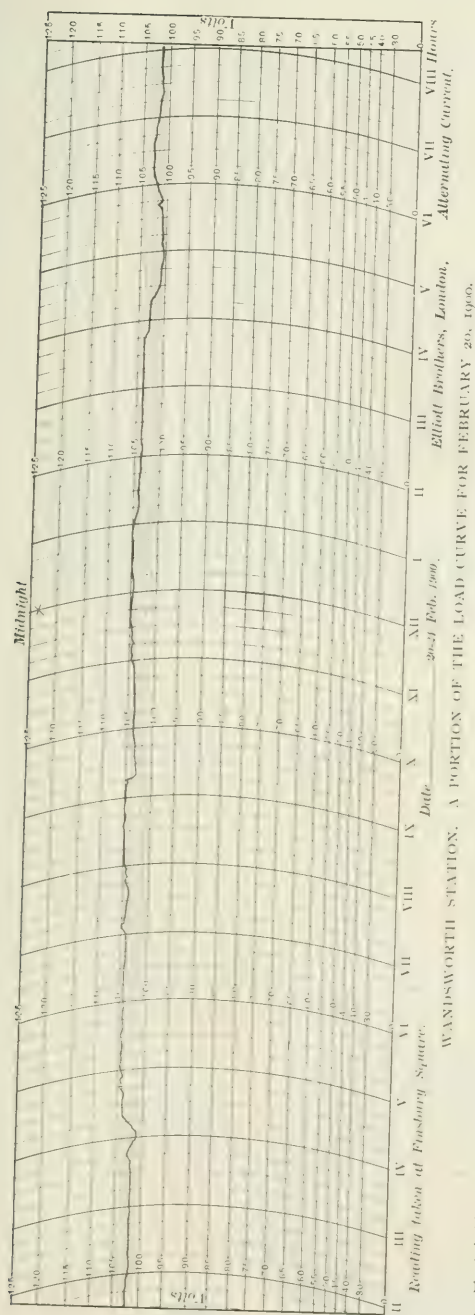
THE BOILER ROOM, WANDSWORTH STATION.

precisely similar manner, but the weighing machine is of a self-recording make, and the conveyors themselves are of the push-plate type instead of the chain type. The motors are of the Westinghouse company's manufacture. The apparatus is capable of handling 40 tons of coal per hour.

The engine room is 60 feet in width by 110 feet in length, and contains six single-phase alternating sets of 2,000-2,200 volts at 100 periods and 180-kilowatts capacity, installed on the side of engine room next to the boiler room. On the other side provision has been made for five 400-kilowatt two-phase 2,000 to 2,200-volt alternators of 50 periods, now on order, to be driven one on each side of a Mordey inductor alternator. To provide for the practical parallel working of these machines of different periodicities, and for economical working at times of light load by the use of one engine and alternator only, a motor generator has been provided as at St. Luke's. The variation in voltage as registered by the automatic recorder is shown by the curve reproduced on the opposite page. The exciting current is supplied by three continuous-current compound-wound dynamos driven by marine-type cross-compound engines fitted with electric control governors. The steam piping is similar to that of St. Luke's, save that there is no cross feeding between the ends of the building. The overhead cranes are of 20-tons capacity each. Circulating water from the Wandle comes into two separate tanks beyond the foundations (for



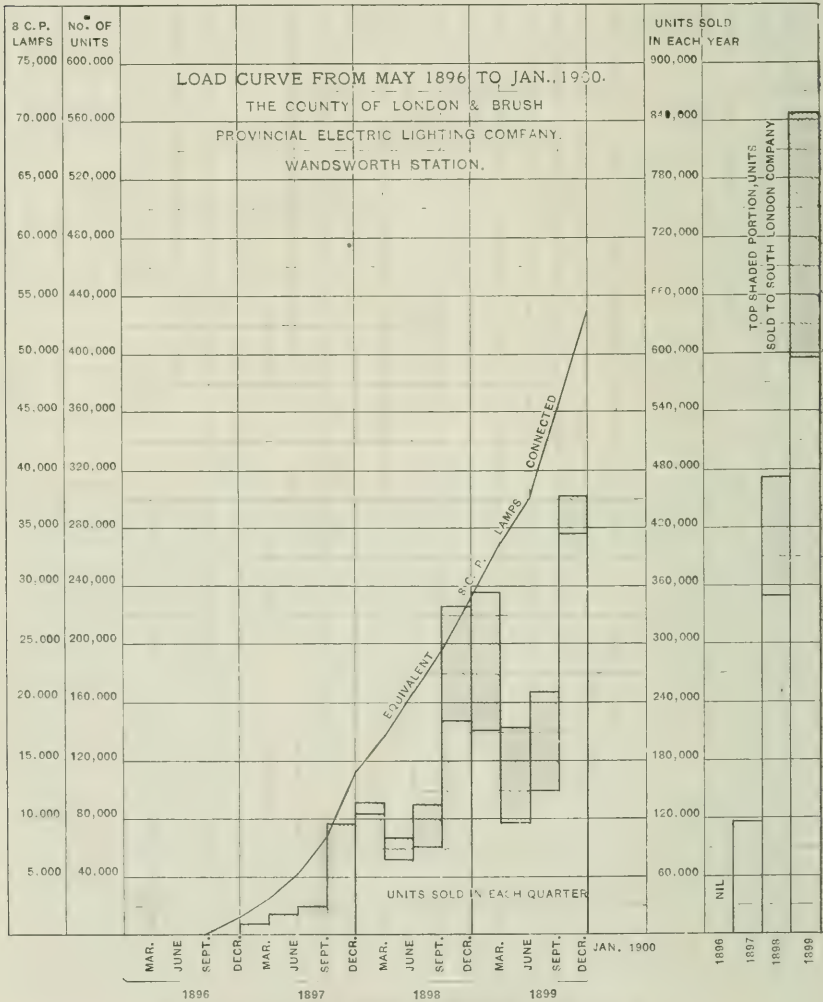
THREE BRUSH EXCITERS AT WANDSWORTH STATION.



future extensions) and is circulated through the engine condensers, which are placed in this case under the floor level, by means of steam-driven centrifugal pumps, one of which is spare. The air pumps are also under the floor level and are driven by a disc crank off the engine shaft. The condensed water is led off from these pumps by gravity to a tank connected with a feed pump with automatic valve, admitting or shutting off steam according to the quantity of water in the tank, which lifts the water to a feed-water tank similar to that in St. Luke's station.

As showing the extent of the area supplied from this station, it may be mentioned that while Roehampton by Richmond Park Gates on one side is distant along the route of mains from the Wandsworth station $3\frac{3}{8}$ miles, the furthest point in Streatham still within the district of the Wandsworth Board of Works is $5\frac{1}{4}$ miles, and Clapham by way of Battersea (a long detour having to be made to avoid passing through more than was necessary of the Battersea area), is distant from the station $5\frac{5}{8}$ miles. Camberwell Parish, however, which extends $5\frac{1}{4}$ miles from north to south and $2\frac{1}{4}$ miles from east to west,

has its extra-high-tension distributing station at a distance of no less than $10\frac{1}{4}$ miles from the Wandsworth station, and the extreme point of distribution in St. George the Martyr, Southwark, is $13\frac{3}{4}$ miles from Wandsworth, while the extreme point in St. Olave's parish is $13\frac{1}{2}$ miles, and is within the comparatively short distance of $2\frac{1}{4}$ miles of the City Road station, from which, however, several geographical and especially local conditions at present prevent its obtaining a supply. The curve shows the increasing load from May, 1896, to January, 1900.

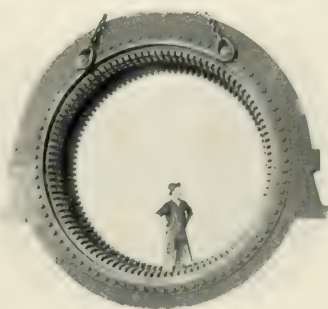




WANDSWORTH STATION.

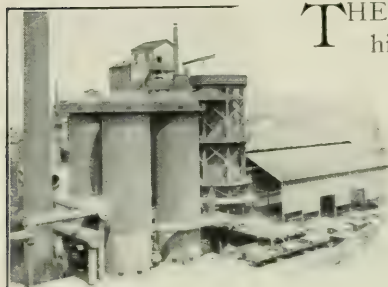
In the Wandsworth, Camberwell and Southwark districts, the length of trenching and reinstatement to date amounts to about 75 miles. The length of pipes laid in is over 150 miles, while high-tension and extra-high-tension cable amount to nearly 50 miles and the low-tension cable to over 52 miles. With higher voltage on secondary mains, viz., 200 volts as against 100 volts on the north side, the number of transformer boxes for the much larger area is about the same as served from the City Road station, namely, 50, with three extra-high-tension converting and distributing stations above ground.

The data and photographs from which the accompanying illustrations were made were supplied by Mr. A. J. Lawson, the engineer and manager of the County of London Electric Lighting Company.



MOTIVE POWER FROM HIGH-FURNACE GASES.

By Bryan Donkin.



The Blast Furnace at Seraing.

THE idea of utilising the gases from high furnaces in internal combustion engines to produce power originated almost simultaneously in England, Belgium, and Germany. Gas engines, as is well known, have now had a life of about thirty years. They were at first driven exclusively by town or lighting gas. About twenty years

ago Mr. Dowson proposed and succeeded in manufacturing a much cheaper gas from the combustion of anthracite or coke. Of this, known as power or producer gas, there are many varieties. It remained to discover that the gases from high furnaces are similar in quality, being really nothing more than ready-made, rather weak producer gas, and to apply them for the generation of power by explosion in a gas-engine cylinder. The idea was first turned to account about six years ago, and the great progress already made justifies the belief that we have here a new, cheap, and most valuable power agent.

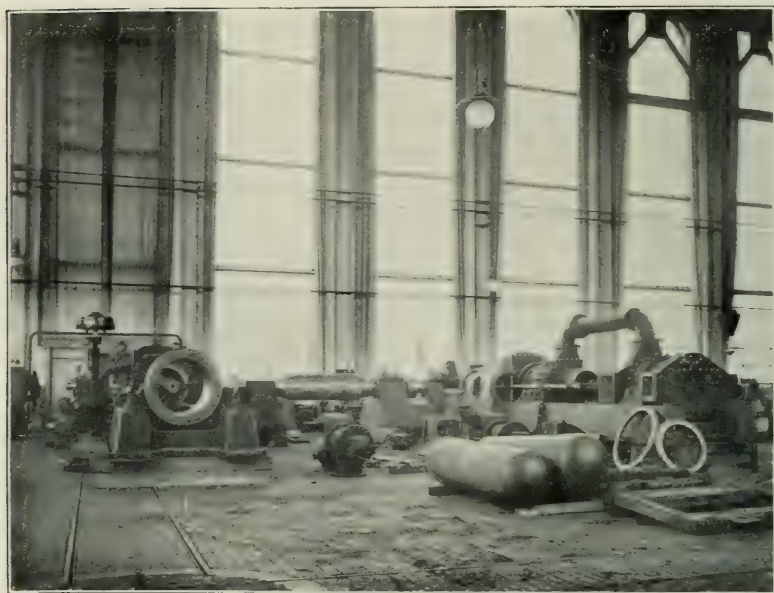
The successive steps in utilising these gases may be thus summarised: Thirty years ago they were considered of no value, and were often burnt off at the mouth of the furnaces. They were next partially used, by retaining a portion to heat the air for the blast and burning a larger proportion under boilers to generate steam for driving the blowing engines. No attempt was made to burn the gases economically, and a considerable quantity was wasted. In 1894 attempts were made in Scotland, at Wishaw, near Glasgow; at Seraing, in Belgium, and at Hörde, in Germany, to explode them in an engine cylinder, in the same way as producer gas, instead of under boilers.

The whole secret of the marvellous mechanical expansion of the past half-century is written in one word—economy. In materials, this has progressed so far that “waste products” are rarely now heard of. In the field of power, less visible but no less real wealth is still allowed to go to waste to an enormous extent; but attention is turning to some of the greatest channels of loss, and foremost among these stand the iron furnaces of the world. The development of the gas engine to the point where this huge waste can be stopped is an epoch-making event in the history of material civilisation.—THE EDITORS.

Complete success attended these pioneer efforts. It was found that, when thus utilised, the quantity required was only one-fifth of that needed when burnt under the old system, and this discovery has been very fruitful, especially in Germany and Belgium, where the subject has till now attracted much more attention than in England.

At the outset the difficulties to be overcome naturally appeared formidable and almost insuperable. To the idea as proposed to them, the ironmasters objected that the gases were too poor to be ignited in an engine cylinder, too variable in composition and pressure, that they issued from the furnaces at too high a temperature, and, above all, were so laden with dust, chiefly metallic, that they would clog the working parts of an engine. Modern science and intelligent engineers have known how to meet all these objections, and even to turn some of them to good account. The variations in composition of the gases were found to be less serious than were anticipated, and dependent upon the kind of fuel, ore, and fluxes used in the furnaces. Fluctuations in pressure were also avoided by passing the gases into a holder before sending them to the engine, and the quantity generated per ton of iron is so large that these difficulties practically disappear. For ordinary work, even a gas holder is not now considered necessary. The high temperature of the gases is also easily reduced by passing them through pipes and spraying water upon them. At Seraing they are led through vertical pipes, meeting falling sprays of cold water.

The low heating-value of high-furnace gases is due to the small proportion (about 26 per cent. or 27 per cent.) of combustible gases, chiefly CO, the rest being mostly inert nitrogen. At Wishaw the gases contain 24 per cent. CO and 27.8 per cent. of combustible gases, and at Frodingham 27 per cent. CO and 28.8 of combustible gases: thus they approach the lowest limit at which gases will ignite at all. Their heating value varies from about 95 to 126 BTU per cubic foot, but the latter was obtained at Wishaw with comparatively rich gas made with coal, whereas most blast furnaces, except in Scotland, are fired with coke. The values obtained are: Frodingham, 102 BTU per cubic foot; Seraing, 110; Hörde, 112; Differdingen, 105 BTU per cubic foot. Ordinary producer gas has a heating value of about 140 to 150 BTU, and lighting gas of 500 to 600 BTU per cubic foot. Nevertheless, singular as it may appear, high-furnace gases give, in the few trials yet published, a higher thermal efficiency than either of the two other kinds, as much as 31 per cent. of the heat given to the engine having been converted at Seraing into work, as shown by the indicator diagrams. This satisfactory result is obtained in two ways.



1,000 HORSE-POWER OECHELHAUSER GAS ENGINE FOR FURNACE GAS.

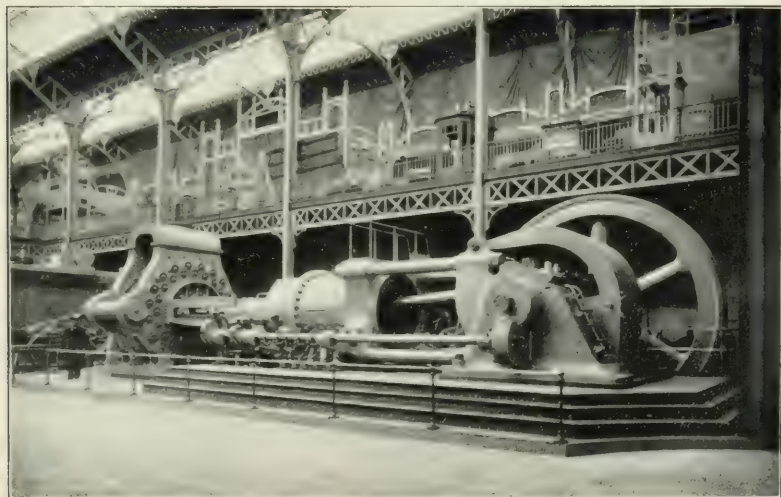
This photograph was taken, like the one on page 426, while the engine was in course of erection in the works of the builders, the Ascherslebener Maschinenbau Aktiengesellschaft. The view is taken from the blowing-cylinder end. The double-acting gas cylinder is placed between the crank shaft and the blowing cylinder, the engine being a blast-furnace blowing engine.

In the first place, the proportion of air admitted to mix with the high-furnace gases and form an explosive charge is much reduced. Before any gas can be burnt in an engine cylinder, it must, as is well known, be diluted with a given proportion of air. For lighting gas the ratio is about 8 to 1, for power gas 1.4 to 1, while with high-furnace gases the size of the air and gas valves must be so adjusted that about equal quantities of both are admitted to the cylinder. These values must be taken as only approximate, as the quality of all these gases, and therefore their heating value, varies much from time to time.

Engineers can also remedy the low heating-value of high-furnace gases in another way, namely, by compressing the charge more highly previous to ignition; it is this compression which produces the high thermal efficiency. It is now known that compression of the gaseous charge in an engine cylinder is the keynote to greater economy in working. But if gases of comparatively high heating-value, such as lighting gas, are much compressed, premature ignition frequently ensues, with all its undesirable consequences. The lower the heating value of the gas, the higher the compression it will bear without such

risk; and to this high compression blast-furnace gases lend themselves better than any other power agent yet utilised. So completely has the difficulty been overcome that no trouble has yet been found in any case in firing the charge, but in all the tests made, and in the regular work of several engines for two or three years, ignition has always been obtained with certainty.

Another, and perhaps the most important, objection to the use of these gases is the amount of dust they contain. This is still a difficulty, and requires to be met in different ways for each furnace treated, as in no two iron works are the gases exactly the same. Professor Witz, who has devoted much attention to the subject, estimates that the gases when they leave the furnace contain 125 grammes of dust per cubic metre. Of this quantity about 100 grammes are heavy metallic dust, which is deposited automatically in the pipes and passages, and collected, being usually returned to the furnaces. Nearly all the remaining 25 grammes are got rid of in the purifiers and scrubbers; about 2 to 3 grammes per cubic metre remain in the gas when it reaches the engine cylinder, and are blown out with the exhaust. At Seraing I collected some of this dust, which I found fine and soft to the touch, like flour, not gritty like sand. It is this residuum which some writers have considered so deleterious, and likely to attack the parts of the engine. This view was supported at first by Herr Lür-

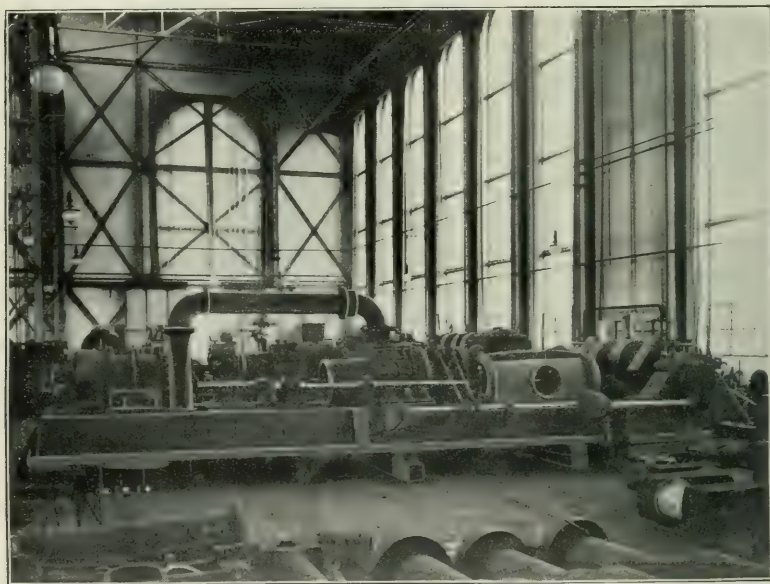


THE GREAT GAS ENGINE AT THE PARIS EXPOSITION

Operated with city gas 1,000 horse power, with furnace gas 650 horse power. A counterpart of the blowing engine at the Cockerill works at Seraing, Belgium. Delamare, De-boutteville & Cockerill system; exhibited by the John Cockerill Works, Seraing.

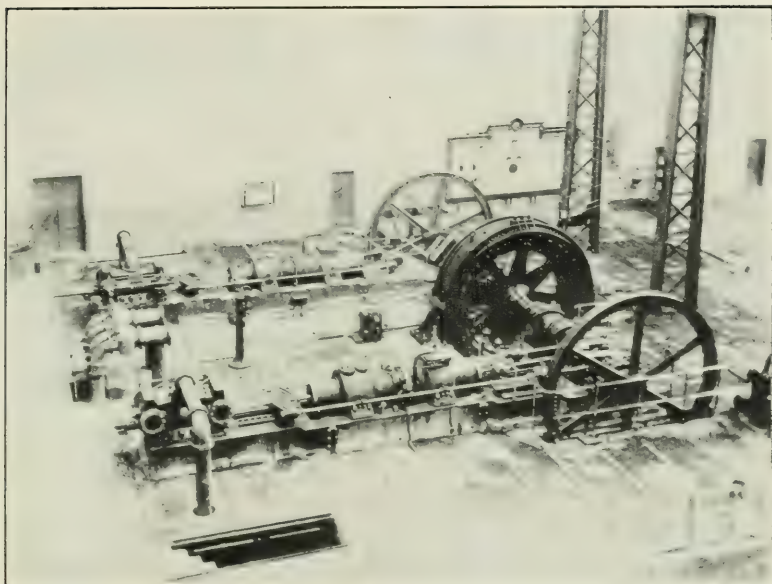
mann in a paper in *Stahl und Eisen*, 1898. Several engines have now been working for some years without any trouble arising from the dust, and Herr Lürmann is now of opinion that the difficulty has been overrated, and can be overcome by the high compression exerted and high speed attained by the motor piston.

In all furnaces, however, the amount of dust the gases contain, and consequently their treatment at their exit, vary. Mr. Thwaite has proposed and patented a method of cleansing the gases electrically, by passing them through an electric field, but this hardly seems necessary except in special cases. At Wishaw the gases, as already stated, are generated from "splint" coal, and are led, on leaving the furnaces, through condensing pipes to recover the tar and ammonia. They are then passed through a scrubber and a purifier, and thence to the gas holder and engine. The usual rate of working the furnaces is one ton of coal or coke to one ton of iron melted. At Seraing the gases are comparatively poor, and contain a good deal of dust; they are washed and sometimes led through pairs of coke scrubbers, moistened with water from Koerting steam injectors. At Hörde the gas is simply passed through a scrubber and a sawdust purifier, in exactly the same way as producer gas, and no difficulty with the dust has been found at



OECHELHAUSER GAS ENGINE OF 1,500 HORSE POWER FOR FURNACE GAS.

Side view, showing one-half of the engine fully erected, the crank shaft to the right, the double-acting gas cylinder in the middle, and the blowing cylinder on the left.



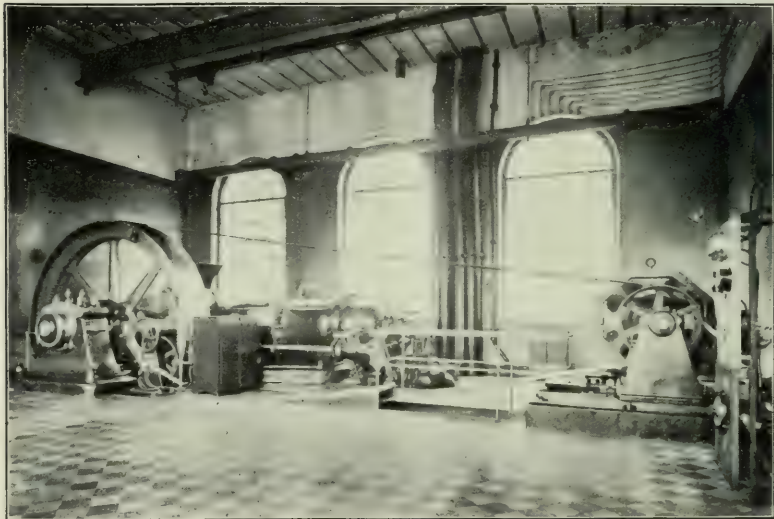
TWIN GAS ENGINES AT HÖRDE, PRUSSIA, USING FURNACE GAS

Oechelhauser engines, 600 horse power, coupled direct to electric generator at the central station of the Hörde Iron Works.

either of these places, though both have been working for some years. At Differdingen the gases are cleansed and cooled as at Hörde. Water collectors at the bottom of the scrubbers draw off the water, after washing and cooling the gases. Considerable difficulty was experienced in starting an engine at the Friedenshütte Iron Works in Upper Silesia, as the gases contained 40 per cent. of heavy zinc dust, but it was finally found possible to purify them in the usual way, by increasing the number of purifiers. By the time they reached the engine they contained practically no dust. This gas has a heating value of 106 BTU per cubic foot.

It is not surprising that such strenuous efforts should be made to overcome the difficulties in dealing with these gases, when the advantages to be derived from their utilisation are considered. Even with the present wasteful method of burning them under boilers to supply steam for the engine to blow the furnaces, it has been calculated by the best authorities that about 40 per cent. are wasted, or in other words this percentage might, if properly applied, be available as power for other purposes. But this system is very uneconomical. The chemical analysis of the gases shows that they contain a large percentage of CO, a gas of relatively little value when burnt as fuel, because of its

low heating power, but giving the best results when exploded in the cylinder of an engine. Nor has much attempt been made hitherto to use the gases economically, because the quantity generated is so large that it cannot in any case, with our present methods, be all turned to account. About 400 cubic feet are required when the gases are burnt under a boiler, to produce one horse power at the engine per hour, while according to the latest tests about 105 to 110 cubic feet are



ENGINE OPERATED BY BLAST-FURNACE GAS AT THE COCKERILL WORKS,
SERAING, BELGIUM.

Delamare, Deboutteville & Cockerill system, 200 horse power, belted to dynamo.

needed for one horse power per hour when exploded in a gas-engine cylinder. Thus the economy is as four to one, that is to say, for every horse power developed in a steam boiler and engine, four horse power could be generated in a gas engine.

We have here two sources of power at present more or less wasted, namely, the surplus store of gases going to waste in the atmosphere, after the needs of the furnaces have been supplied, and the imperfect utilisation of those now burnt under boilers, when power might be generated from them by direct combustion in a gas engine. The usual standard of working blast furnaces is about one ton of coke burnt per ton of iron made. From 160,000 to 180,000 cubic feet of high-furnace gases are produced per ton of iron smelted, or per ton of fuel burnt. This quantity may be divided into: waste, 16,000 cubic feet, or 10 per cent.; to heat the air blast, 44,800 cubic feet, or 28 per cent.; burnt under boilers, 64,000 cubic feet, or 40 per cent.; available

surplus, 35,200 cubic feet, or 22 per cent.; total, 160,000 cubic feet. Assuming that 10,000,000 tons of fuel are burnt annually in blast furnaces in Great Britain, this gives about 2,000,000 horse power wasted, which might be converted into useful work, especially for the production of electric energy. We have only to consider the immense output of pig iron per day from the high furnaces in England, the United States, and the Continent, to see how vast a store of potential energy is at present untouched. From a furnace in regular work, about 10 horse power may be obtained weekly per ton of fuel burnt.

As regards the application of this power, one difficulty has till now stood in the way, namely, the connection of the gas engines to the blowers supplying air for the furnaces. The latter work generally at about 50 to 60 strokes per minute, while an ordinary gas motor runs at a speed of about 100 to 150 revolutions per minute, according to its size, and gives its maximum efficiency at maximum speed. To adapt the speed of one to the other, several methods have been proposed. Valves of the Lang-Hörbiger and Riedler types are chiefly used, to accelerate the speed of the blowers. But this is a matter of some difficulty, and an important point now occupying the minds of those working in this direction is whether the speed of the gas engines can be diminished. This has been found more or less practicable, and in most new plants the horizontal gas engines are coupled direct to the horizontal blowers. It must be remembered that the larger the gas engine the slower the speed at which it runs. The quantity of gases generated in high furnaces is so great that the largest engines are required to utilise them. It was at first doubtful whether motors of sufficiently large size to meet the demand could be constructed. Until the discovery that high-furnace gases could be used to drive them, gas motors were seldom made in sizes above 100 horse power, or at the most 200 horse power, but a sudden impetus was given to the building of large-power engines, proving satisfactorily that their size presents no difficulty. Most of the large German and Belgian firms now make engines for work with these gases up to 1,000 horse power, or even 1,500 horse power. England is still much behind, and no large gas engines known to me are at work, although some of about 500 horse power are in hand.

It was, however, in England, that the first attempts were made to turn high-furnace gases to good account. In May, 1894, Mr. Thwaite proposed to utilise them in a gas engine, and took out a patent for their treatment. On the Continent, in Germany and Belgium, no special apparatus has been found necessary, the gases being simply drawn

off from the furnace and purified in the ordinary way, and the industry has consequently been much more largely developed in those countries. The first engine driven with high-furnace gases was a four-cycle Acmé, which was started on February, 1895, at the Wishaw Iron Works near Glasgow. Originally of 20 horse power, the engine developed 15 indicated horse power when driven with these gases, which yield as a rule only four-fifths of the power obtained with lighting gas. The engine was tested by Mr. Booth in 1896, when the consumption was about 84 cubic feet per indicated horse power, or 105 cubic feet per electrical horse power per hour, the engine being coupled to a dynamo direct. The gas was especially rich, as the furnaces were fired with coal. A small experimental plant was also put down at Frodingham, and worked well for a year or two. The consumption of this poor gas was about 110 cubic feet per indicated horse power. A more important 160 horse-power plant has been started at Barrow-in-Furness, but no details of its working are available. With the addition of a 250 Premier gas engine, which has hardly begun work as yet, these are all the motors in England, driven with high-furnace gases, as known at present.

The subject has been much more carefully and thoroughly studied abroad, and nowhere more successfully than at the important Cockerill Iron Works, at Seraing, in Belgium. This enterprising firm worked independently of the English makers, and in December, 1895, applied some of the gases from their great furnaces, of which they have six, to drive an 8 horse-power Simplex engine. The discovery that high-furnace gases could be thus utilised was made almost accidentally, while testing the Simplex motor with power gas, and it was the first engine driven with gases generated from coke. It is a four-cycle gas engine resembling the Otto, but with electric ignition, and made with only a single cylinder. The gas had a heating value (taking the water as condensed), of 110 BTU per cubic foot, and the consumption at half load was 187 cubic feet per horse-power hour.

Encouraged by this success, the Société in 1898 started a larger Simplex engine indicating from 150 to 200 horse power, and driving an air compressor, which was tested by Professor Witz in July of the same year. Of this motor, which has now been running successfully for more than two years, and which I saw at work, a view is given on page 428. It has a cylinder diameter of $31\frac{1}{2}$ inches, with 39.3 inches stroke. The speed during the trial was 105 revolutions per minute. The work shown on the brake was 181 horse power; mechanical efficiency, 85 per cent.; thermal efficiency, taking the brake horse power,

20 per cent.; consumption of high-furnace gases about 110½ cubic feet per brake horse power. The result was considered so satisfactory that engines on a much larger scale were planned, and have now been started and tested. Upon this fine power plant, the largest on which trials have yet been made, experiments were carried out at the Seraing Works in the spring of this year (1900). Page 425 gives an external view of a 650 horse-power single-cylinder engine, at the Paris Exhibition, which is exactly similar to the one at Seraing on which the tests were made. As shown in the drawing, the engine is connected direct to the blowing cylinder. Diameter of the engine cylinder, 4 feet 3 inches; stroke, 4 feet 7 inches; diameter of the air cylinder, 5 feet 7 inches; stroke, 4 feet 7 inches; length of the connecting rod joining the two cylinders, 14 feet 5 inches; diameter, 11.8 inches. The experiments were carried out on two consecutive days. In the first day's trial, the engine was tested with a brake, without the blowing cylinder, and gave 573 brake horse power, with a consumption of 123.7 cubic feet of gas per brake-horse-power hour. Mechanical efficiency, 72 per cent.; thermal efficiency, taking the brake horse power, 20 per cent. On the second day the engine was coupled to the blower, and gave 886 indicated horse power and 725 brake horse power, with a gas consumption of 101 cubic feet per brake-horse-power hour. The thermal efficiency, taking the indicated horse power, was 31.5 per cent.

The Hörde Iron Works in Westphalia were the first in Germany to start a gas engine driven with high-furnace gases. In 1895 they began experiments on a 12 horse-power Otto engine, in which the consumption was 141 cubic feet of gas per brake-horse-power hour. From thence they proceeded to motors of larger size, and selected one of a new type, namely, a two-cycle Oechelhaeuser for their work. In this engine there is one long horizontal cylinder with two pistons, and an air cylinder or air pump, worked from the crosshead of the back piston. The engine has no valves or cam shaft; the motor pistons compress the charge between them, and alternately uncover and close the exhaust and admission openings in the working cylinder. The cycle is as follows: A charge of fresh air is drawn into the pump, slightly compressed on one face of the pump piston, and sent on to the compression space of the motor cylinder. On the other face of the pump a mixture of gas and air is drawn in and separately compressed before it is delivered into the motor cylinder. One of the motor pistons now uncovers the exhaust port, and the other the admission ports, immediately after. The fresh charge, as it enters, is highly compressed between the two pistons as they come together, fired electrically, and

drives both out, doing work. As the air port is uncovered a little in advance of the openings for gas and air, a scavenger charge of air is first admitted, to cleanse the cylinder of the burnt products. This engine seems to be especially well-adapted for use with high-furnace gases, with which alone it has hitherto been worked, and several large plants have been ordered, including eight two-cylinder engines developing 1,000 horse power, and another of 1,000 horse power with two cylinders coupled direct to the blowers.

It is, however, on an engine of the ordinary Otto type that one of the best trials yet published has been made by Professor Meyer at Diferdingen in Luxemburg, in 1898. The heating value of the gas was 105 BTU per cubic foot; diameter of the cylinder, 17 inches; stroke, 27.6 inches; average speed, 161 revolutions per minute. The engine indicated 79.5 horse power, with a consumption of 79.4 cubic feet per indicated-horse-power hour. As it was coupled direct to a dynamo, the brake horse power was determined from the electrical instruments and taken at 65.3, and the consumption of high-furnace gases per electrical horse power per hour was 96.7 cubic feet. Thermal efficiency, taking the indicated horse power, 30.2 per cent., taking the electrical horse power at 25 per cent. This is one of the most complete trials made with these gases, and the results with so comparatively small an engine are very satisfactory.

It will thus be seen that the utilisation of high-furnace gases in gas engines has been fairly started in Germany and Belgium on what can scarcely fail to be a prosperous course. Seventy gas engines coupled to blowers similar to the one shown on page 425 and now on view in Paris, have been ordered from the Société Cockerill, and motors giving an aggregate of more than 39,000 horse power have been bespoken from them and from affiliated firms. A large 1,000 horse-power plant has been furnished by the Deutz-Otto Company to the Friedenshütte Iron Works, and others are at Oberhausen and Dudelingen. The plant at the Phœnixhütte is the only one supplied from England. Since September, 1898, the Deutz-Otto firm have constructed and have now at work in Germany twelve engines and an aggregate of 2,100 horse power, while the French Société Otto are making three 600 horse-power engines. Herren Koerting, of Hannover, have also supplied a 100 brake-horse-power engine to the Donnersmarck Iron Works, which has been working successfully for a year, and they have a 600 horse-power engine in hand.

I have seen many plants running, and am of opinion that there is a great future for this work, especially for large-power gas engines.

EDITORIAL COMMENT

The practical application of new sciences gives rise to new professions, and one of importance hardly yet acknowledged is introduced by Mr. James N. Gunn, in his contribution to the special Works-Management Number of THE ENGINEERING MAGAZINE, which will form our next issue, that for January, 1901. The "Production Engineer" is the latest offspring of an epoch whose marvels are yet too new to be fully understood.

The nineteenth century, now in its closing weeks, has witnessed probably a vaster change in the physical institutions of civilisation than the whole sixty or more centuries of which we have the written records in Europe and Asia. The builder, the weaver, the farmer, the handicraftsman, the smith, worked with much the same tools and with substantially the same methods in Nineveh and Babylon, in Rome and Carthage, in old London and New Amsterdam. Progress was thought of as being in degree, not in kind. When the genius built Aladdin's palace in a night, he did it by employing countless myriads of toilers at the task. Labour spending, not labour saving, was the secret of the pyramids and of the cathedrals.

It remained for steam to break through the restraint of the ages, to shatter the old order and to give place to the new. The change was radical and revolutionary. The same functions are still needed, but they are performed by totally different organs. The steam-thresher totally rejects the mechanism of the flail. The battle-ship has hardly even a generic relation to the three-decker. The telegraph is not an evolution from the signal fire. The Oceanic is not an enlarged Mayflower; it is a distinct creature, serving the same ends not only immeasurably better, but by different means.

It needs no demonstration that so complete a revolution must go hand-in-hand with as thorough a re-ordering of methods of control and direction, and of all the co-ordinate institutions which bind the tools of production and distribution into a harmonious system. A new order of managers is needed for the new order of agencies. Similar ability is requisite, but it must be equipped with different knowledge.

This is especially true of the manufactory; it has grown in differentiation and specialisation, not in dimensions only, and its directing intelligence must meet the new conditions. The master in the early days was almost the body of his establishment, carrying out its functions personally. Later he was at least its nervous system, receiving impressions directly, transmitting them throughout the tissue of the fabric, and acting immediately upon the work-performing members. Now he must perforce be centralised as the brain, ever active while the work lives, acutely conscious of every condition, internal and external, but of necessity receiving and transmitting through intermediary means, balancing and co-ordinating the whole organisation, though the several members may be independent and almost ignorant one of the other. This means of bringing information and carrying direction—this nervous system—is as essential as the active central brain. Where it is weak the functions of the mechanical body are performed feebly, indefinitely, and often amiss; where it does not work the entire organism is paralysed and dies.

* * *

It is this vital system of sensation and transmission that is meant by the term "factory organisation," and the study of its constitution, its health, disorders,

and remedies, of its upbuilding and fostering, is comprehended in the larger science of "Works Management." The point which must be clearly understood is that the mastery of the study is not merely an aid or an advantage in gaining success in modern manufacturing; it is an absolute necessity. Factory organisation is not an auxiliary to, but an integral part of, industrial prosperity. This is the gist of Mr. Church's article in this issue (page 391), and it is a conception which cannot be too strongly urged upon works managers. The keenness of international competition is waxing every day. It is growing harder and harder for any but the fittest to survive. The gain to the world at large is enormous, for it means a constant progress in the economy of production; but the manager who does not keep up with the rush of evolution will infallibly "go to the wall."

* * *

It is to the formulated conclusions—the newly-growing literature—of this lately-recognised science that *THE ENGINEERING MAGAZINE* has been foremost in devoting attention. And as a summarisation of the nineteenth-century work in this field, and a basis for the advance of the twentieth century, the Magazine will devote its next issue—that for January, 1901—to the most comprehensive current review of the subject yet presented. The leaders in the thought and practice of the old world and the new will bring to this volume the best fruits of their study and labour. The themes will cover the great departments of industrial activity, the great problems which confront the manager in handling the mechanical and the human agencies he must use. The illustrations will represent the greatest establishments of the world, the most advanced practice in labour saving and labour management. It will be, in short, a text-book of plain teaching why, when, and how works organisation is to be effected—an array of concrete examples illustrating and enforcing the text. It is dedicated throughout to the practical

presentation of the new applied science, "Production Engineering."

* * *

Now that the Paris exposition is over it may not be amiss to call attention to the manner in which many exhibitors wasted their opportunities. The prime object of an exposition, from the exhibitor's standpoint, is the business advantage to be gained by the presentation of his business; in other words, the advertisement he gets. In spite of this trite statement, it must be said that a majority of all the exhibitors went to large expense to install handsome exhibits to little or no commercial purpose, simply because these same exhibits were wholly or nearly wholly neglected.

In the great majority of cases, attendants at expositions are altogether unfit for the difficult task. Instead of sending men familiar with several languages, courteous and winning of manner, and thoroughly familiar with the exhibit and its commercial possibilities, it is the usual practice either to place an exhibit which has cost large sums in the care of an ordinary mechanic, or a supercilious official, or, as in many cases at Paris, to leave the whole affair alone and neglected for the greater part of the time. In many instances the charge of an exhibit at an international exposition is regarded as a sort of vacation, and is given to some favoured individual who enjoys himself away from his post more often than not. Even when on duty such individuals appear to regard the inquiring visitor as a person to be snubbed, while very often any desire to investigate the construction of the exhibit is considered as an attempt to steal ideas. If all parts of an exhibit are not to be freely exposed and explained, it is incomprehensible to the ordinary mortal that it is exhibited at all.

It would doubtless cost more to place competent attendants in charge of exhibits than to leave them neglected or in the hands of the ignorant and incompetent, but it would be far wiser economy not to exhibit at all than to follow the methods of many otherwise sensible firms who might be named at Paris.



REVIEW OF THE BRITISH PRESS

The Training of Engineers.

THE subject of engineering education will doubtless always be a fruitful question for discussion, but at the present time it appears to be attracting especial attention on both sides of the Atlantic. In several issues of *The Engineer* the matter has been discussed both editorially and in correspondence, and some interesting phases brought forward.

The chief difficulty about the matter appears to lie in the fact that many people suppose that a technical education makes a man a full-fledged engineer, capable of coping with all the practical problems of the profession. This is more than is expected of other professional lines, and more than can reasonably be asked. The student of law or of medicine is expected to devote several years to office or hospital practice before he can rightly be assumed to be capable of handling the difficult cases of independent practice. Even in engineering societies and institutions the membership classifications provide for departments of students or of junior members, lower in professional standing than full membership, and expressly intended for those who have graduated from technical institutions and schools, but who have not yet had sufficient practical experience to entitle them to the higher grade. Then, too, it must not be forgotten that engineering is a business as well as a profession, and that the business side cannot be, or rather is not, taught in technical schools. It is not enough to design machines which will work well and be economical in action; they must also be capable of being sold at a profit. Not only must the principles and methods of cost-keeping be understood, but also the equipment and operation of works, the management of men, and the commercial details of the profession. It is not meant that the engineer must personally conduct all these departments of the work, but he should know how they are done, and be competent

to plan their execution and capable of harmonising the mechanical with the commercial side of the work.

These details of the engineering profession must be acquired in actual practice, but even there they are not acquired unless they are studied. In this respect again the profession is not greatly different from some others.

"The mechanical engineer without plenty of brains is certain to turn out a failure. Now, one of the special manifestations of brain power is keen watchfulness of surroundings—an appreciation of environment. To put this in somewhat different words, some men enjoy the power in going through life, of picking out and acquiring just that kind of knowledge which will subsequently be of use to them; others do not possess it at all. The able man learns something, acquires an experience in some way, and this he utilises subsequently with perhaps infinite advantage to himself; another goes through life without recognising differences, drawing deductions, or accumulating evidence. The first man is termed clever; the second is called uncomplimentary names.

"In truth, the successful mechanical engineer in the present day must turn his attention to a hundred things not dreamt of in the philosophy of the technical college. It is a matter of every-day notoriety that some firms succeed and others fail under circumstances apparently similar. Possibly it will be found on examination that there is nothing to choose between the members of the two firms, so far as mechanical skill is concerned. Our older readers will be able no doubt to call to mind, each for himself, a case in point. One firm has been able to push trade and beat competition, simply because its members possessed a special commercial aptitude which the luckless firm lacked. Unfortunately, young men training for engineers are not told these things, and only too often regard the commercial side of engineering with contempt.

We have nothing to say concerning the extravagant and careless, who cannot look after their own income, and leave parents and guardians to get them out of their difficulties. These young men have often much that is admirable, much that is desirable in their characters, but they must not complain if they do not obtain lucrative employment the moment they leave the shops. We speak now of steady, clever young men who have acquired the idea that to think of money in connection with steam engines is derogatory to science. All that, they fancy, is to be left to clerks. The cost of a steam engine is not a thing to be considered. We have met with more than one man who was disgusted to find that steam engines were made and sold at a profit, or not at all. If we have written to any purpose then it will be recognized that as matters now stand in the engineering world the pupil or apprentice must keep his eyes open, and try to learn for himself what the machinery made, more or less under his eyes, costs. He must learn the relations between plant and labour, and, in a word, waste no opportunity of learning everything that concerns the manufacture and cost of machinery. Help can be given in technical colleges. The very insistence on the fact that an engineer ought to know the price of the materials which he uses will at least serve as an awakening to a whole army of young men, or we are much mistaken."

Progress in Rapid Telegraphy.

THE rapid telegraph system of Pollak and Virag has already been described and reviewed in these columns, and it will be remembered that by its use messages can be sent over telegraph wires at a rate of more than 1,000 words a minute, a speed as high as 1,600 words per minute having been transmitted and recorded in Morse characters.

Not content with this achievement, the inventors have modified and improved the apparatus so that instead of recording the message in Morse characters the words are written in a modification of Latin script, so that they may readily be read by any one without especial knowledge of telegraphy. This is particularly valuable, as the system can be used for the rapid transmission of newspaper messages in a form

ready to be sent to the printer direct, without the loss of a moment's time in transcribing.

A detailed account of the manner in which this remarkable result is attained is given in an interesting paper by Mr. C. H. Garland in recent issues of the *Electrical Review*, from which we give some extracts.

It is impracticable to give in detail the construction of the apparatus, but it will suffice to state that the original Pollak-Virag system was based upon the use of a specially constructed telephone, with optical and photographic attachments, registering the vibrations of a diaphragm thrown into motion by currents following in very rapid succession. The messages were sent by means of a perforated slip with three rows of perforations, the upper row being for guiding purposes, and the upper and lower row corresponding respectively to the dots and dashes of the Morse system.

The single telephone apparatus used in this early form of machine was only capable of elongating the light ray in a single direction. By variation of the direction of the current, the duration of the current, and the strength of the current, it was found that the waves written upon the sensitised paper by the light ray could be elongated either in a vertical or horizontal direction. By the arrangement of the perforations of the sending slip it was found possible so far to control the membrane vibrations that letters could be written in readable Latin form.

This operation involves the use of two diaphragms and two separate telephones, their vibrations being compounded upon a single mirror pivoted upon three points, one fixed and the other two movable. The perforations of the slips for the new system are necessarily more complicated than in the earlier apparatus. They are divided into two series, of which one sends the vertical components of the letters, while the other series furnishes the horizontal components. This additional complexity of the transmitting slip does not entail any difficulty, as the ribbons are prepared in such a manner that the perforations necessary to send a complete letter are made by a single impression.

The great advantage of the system, apart from its speed, lies in the fact that no

delicate and complicated synchronizing apparatus is necessary, as in other forms of writing and printing telegraphs. The objection to it is the fact that two line wires are required, although the speed is such that far greater transmitting capacity is obtained than would be possible with the same lines, wires and ordinary apparatus.

It is contended that the output of the apparatus surpasses that of any of the present multiplex type printing systems. The output of the Baudot system is reckoned at 400 messages of 10 words each per hour; of the duplex Hughes, 180 messages of the same length, while the Wheatstone, using the Morse code, and requiring subsequent transcription, is given as 2,400 messages. The Pollak-Virag system, on the contrary, can be operated at a speed of 3,000 messages, so that the output per wire is more than seven times that of the Baudot and sixteen times that of the duplex Hughes.

High Temperatures.

WE have already referred in these columns to the process of Dr. Goldschmidt, by means of which intense heat is obtained by the combustion of aluminum in the presence of a metallic oxide. The more recent practical applications of this process forms the subject of a paper recently presented before the Iron and Steel Institute by Mr. Ernest F. Lange, from which some interesting abstracts may be made. Mr. Lange's paper is based on his observations during an examination of the workings of the method at Essen, and gives especially some examples of welding by the process.

Briefly the process of producing the high temperatures is the combustion of powdered metallic aluminum with oxide of iron, together with some igniting powder; the latter consisting of barium peroxide, or a combination of nitrates or chlorates. The function of the igniting powder is simply to enable the combustion to be readily started.

After the combustion is in progress the aluminum and oxide of iron mixture may be added and the heat maintained long as may be necessary. Pyrometer experiments with the Wiborg thermophone have established the temperature reached in the operation at about 2,900 degrees C., or about 1,000 de-

grees C. higher than that reached during the hottest period of the Bessemer blow. The work represented by the heat energy is practically equal to that originally used for the reduction of the aluminum in the electric furnace. The resulting product of the operation is practically an artificial corundum, which can either be used as a grinding material, or sent to the electric furnace to have the aluminum reduced from it again.

The applications of this convenient process are numerous. By it the reduction of chrome and of manganese can readily be accomplished, the resulting purity of the product enabling ferro-chrome or ferro-manganese to be made free from carbon, and thus capable of use for addition to steel without altering the carbon content of the product.

One of the most practical applications of the process, however, is for welding. The operation is conducted by pressing together the two ends of the bar to be welded. There is then placed round the part to be welded, but separated from it by a fixed distance, a form made of thin iron sheeting, supported by being packed round with molding sand. The aluminum-iron-oxide combustion is then effected in a crucible of fitting size, and the contents of the crucible poured into the form. As soon as the part to be welded has taken up sufficient heat, the weld is accomplished by pressing the parts together by means of a suitable clamping arrangement. The temperature can be raised to suit the character of the work by diluting the oxide of iron with sand, magnesia or lime. Different mixtures of the material may thus be made, but it has been found that two varieties, known respectively as "Thermit P" and "Thermit R," answer all practical needs, the result being regulated also by the quantity used.

The advantages of welding by this process are similar to those existing in electric welding, with the great advantage of extreme portability. With a supply of Thermit, a sheet-iron case, a few clamps, the work can be done in the field, aloft on a skeleton structure, or below in the engine room of a vessel, no current or machinery being necessary.

Mr. Lange describes the operation of welding 7-inch girder rails, the weld tak-

ing the place of a fish joint, and providing a complete electric bond.

"A good joint having been made between the two ends, strong clamps were then secured to the rails, some 9 or 10 inches from the joint, and connected with each other by means of a strong bolt on each side of the rail. The sheet-iron form was then brought round the part to be welded, and backed round with fire clay. The reaction was then started in a crucible capable of taking 15 kilogrammes of the aluminum-iron-oxide mixture, and at the end of the reaction, which lasted about a couple of minutes, the contents of the crucible were poured into the sheet-iron form surrounding the joint, care being taken that the slag made the first contact with the cold surfaces. After waiting another couple of minutes, the rail ends were judged to be sufficiently heated, and a few turns of the nuts on the tension bolts were given equally and simultaneously and the weld effected. An important feature about this welding process is that the layer of slag or corundum which first forms round the part to be welded also protects the joint from oxidation. After the welding, the solidified mass can be knocked away by a few light blows from a hammer; but, as a rule, it is better to allow it to remain on for some time, so as to allow of a more gradual cooling of the rail joint. On knocking away the mass, it was seen that the sheet-iron form was so little damaged that it could be used over and over again."

The applications of this ingenious process are almost innumerable, and Mr. Lange does not attempt to describe many of the possibilities. One very useful one, however, is the repairing of defective steel or iron castings, such as gear wheels, and the like, by burning on additional metal at the defective place and then machining it down to the desired shape.

Priggishness in Science.

MODERN engineering has become so entirely a matter of applied science that it is to a great extent identified with scientific teaching, and hence the interest taken at the present time in technical instruction.

This demand for practical instruction appears to have encountered a decided ob-

stacle in the form of the great army of scientific men who believe in knowledge solely for its own sake, and somehow feel as if it is degraded by practical application. We hear of pure mathematics, and pure science, these terms necessarily implying that there are forms of science and mathematics which may be considered as impure. Indeed, a German professor, in the introduction to an otherwise excellent treatise on the infinitesimal calculus, gravely stated that he objected to the use of any illustrations of rates and variables taken from such subjects as falling bodies and other physical phenomena, because they tended to introduce conceptions incompatible with the idea of pure mathematics, which should be devoid of any material connections.

Speaking of this phase of technical instruction, a paper in *The Engineer* says:

"A great deal of harm is done to technical progress in this country by scientific cant. The Royal Society represents both scientific and scientific cant. According to scientific cant nothing that is technical is scientific. Science is only concerned with phenomena, and not with their useful application. If you experiment with 37 grammes of steel in a Berlin porcelain crucible, or especially in a tiny electrical furnace, with a standardized platinum pyrometer and a spectroscope, you are doing scientific work; but if you work with a ton in a converter, this is merely technical—though you will be patronizingly told that your work may throw some light on scientific questions.

"No scientific man will deny in words that the probable ultimate use to man is the criterion of value of a scientific discovery; but all the same the tacit assumption is that anything technical is unscientific. The common type of scientific man thinks his knowledge of necessity includes all technical knowledge; but he cannot for a moment believe the technologist's knowledge may include his. The result of this sort of scientific priggishness is that technology is discouraged, and made out to be less important than it is, while unimportant work is exaggerated as to its value. Pure science, as it is called, is considered something much higher than applied science. This is the wrong way

round. The terms are misapplied to being with. One kind of knowledge is not purer than another. What is called pure science is really merely the raw material, and the raw material has to be worked up by the engineer for the use of man. Which is higher, the raw material or the finished product? In the case of ordinary raw material, such as iron, it is produced intelligently, with the view of being worked up; that is to say, it is produced for a given purpose. The scientific man does not work intelligently in this sense. He produces raw material without knowing or caring whether it can be worked up, just as the insect produces silk. If anything, he prefers what cannot be worked up. The sperm whale sometimes produces ambergris, and also produces other matter, but we do not admire the sperm whale because he unintelligently produces what is sometimes valuable when worked up. This view of pure science is so unconventional that few readers will agree with it; but it may be largely true all the same. In France scientific cant is perhaps more rampant even than here. It is represented by the Academy of Sciences. One idea is that it is beneath the dignity of a scientific man to apply anything to technology. If he finds out a new phenomenon he should read a paper on it, but it is below his dignity to take out a patent. One form of hypocrisy in connection with this is the pretence that the scientific man works entirely for love of science. He has no wish to advertise himself or bring his name forward. If one scientific man says, in the interests of pure science, that he has done something which another man claims, there is generally a very acrimonious dispute—all in the interest of pure science, and not at all in those of advertisement. The worst of it is that the purely scientific man does not confine himself to his pure science, but considers that his knowledge covers all applied science *ex officio*, and the public unfortunately shares his view. This is seen clearly in the case of the Royal Society. It is absolutely non-technical, technical distinction is a bar to entering it; but when the Government wants advice on technical matters it goes to the Royal Society on the assumption it includes technology. Take, for example, the new National Physical Lab-

oratory. Money was got from the country on the ground it was to be of commercial value. But the control is in the hands of the Royal Society, instead of the Civil Engineers' and kindred technical societies. The result will be that, instead of being of technical use, the laboratory will probably degenerate into an expensive institution for determining the value of the Clark cell to seven significant figures. The topsy-turvydom of the position of so-called pure science is nowhere more strongly shown than in the case of electric railways and observatories. The industry is hampered in many cases because its development would disturb magnetic observations, which, as far as can be seen at present, are of no value at all."

Railway Speeds.

IN discussing the question of railway speeds a correspondent in a recent issue of *The Engineer* makes the very pertinent query as to why railway statistics are always reckoned in mileage and never on a time basis. The great bulk of railway expense charges are incurred on a time basis, the so-called "hourly burden," and hence time consumed is the true function of charges which vary in proportion to time.

"So long as the passenger holds a ticket he has the right to occupy the company's carriages; he has at least three of the company's servants directly waiting on him and many others indirectly; and coal is being consumed on his account." The same is true at a hotel, where the expenses are incurred on a time basis and the charges are also proportional to the duration of the stay.

Under these circumstances it hardly seems reasonable to make the charge for travel by fast trains higher than for the slower ones. The faster a train is run the sooner it reaches its destination and may be used for a return journey, and although the actual running cost of operating the fast train is somewhat greater than the slow train, yet the large proportion of fixed charges, all of them on a time basis, are proportionally reduced for the fast trains over the slow ones.

A similar state of affairs may be found with steamship lines, although more intelligently managed. There it is found that the advantage of fast liners lies in the fact

that more trips can be gotten out of them per year, while the salary lists, afloat and ashore, are not increased, and although the prices on the record breakers are somewhat higher than on the slower boats, yet the increased charges are made because of the fact that people are willing to pay more to travel quickly, rather than to any greatly increased cost of operation. The greater cost of fuel is the principal item, but this alone is not sufficient to outweigh the saving in the proportion of fixed charges.

In machine works one of the greatest advantages of piece work over the direct knowledge of the exact cost of each piece, lies in the vastly greater output per unit of fixed charge, and it is in this direction that the most intelligent efforts at cost reduction are now made. In the cost of railways the whole cost of the permanent way is a charge independent of the speed and number of trains, and the more service it can be made to bear the less each passenger should be obliged to contribute. So long as the fast trains can be made to yield more revenue the higher charges will doubtless continue to be made, but it hardly seems reasonable to charge the slow passenger less than the one who rides in the fast train when the former really costs the company more to carry him.

Insularity in Engineering Work.

In the presidential address of Professor R. H. Smith, recently delivered before the Civil and Mechanical Engineers' Society, are sounded some timely words on the necessity for Great Britain becoming aroused to the mistake of isolating herself from the rest of the world in matters relating to mechanical and engineering work.

England has so fully realised the benefits resulting from freedom in trade, so far as commercial affairs are concerned, that it is more than important that British engineers should shake off the conservatism of insularity and become aroused to the fact that they are in competition with a world of which they form only a part, concerning which they must keep themselves informed, and against which they must be prepared to contend.

Says Professor Smith:

"The restricted knowledge that the bulk of Englishmen possess of the general facts

concerning other countries than their own, hinders very greatly that mutual friendly understanding which is needful as well to us as to those of other races, in order that we may successfully pursue our rivalry and competition to the benefit of both. In this respect England, I think, used to be the leader of the nations; we used to be less ignorant than any of the others were. But latterly we have confined our attention so much more tenaciously to the one object of money accumulation in individual pockets that we have not had time enough to keep ourselves acquainted with the advances that other countries have made and the change that have occurred in them.

"The extremely small number of Englishmen who have this year visited the Paris Exhibition indicates that we have largely ceased to care to learn what other people are doing. There is, in fact, an enormous quantity of interesting and beautiful improvement in detail to be learned there, but we seem indifferent to it. At the present moment very few of our home engineers have been forging ahead in the use of superheated steam in engines, nor how the constructive details of engine valve gears and engine governors have been vastly improved.

"Roughly speaking, we have no exhibits at Paris this year; at least our exhibit is microscopical to the real magnitude of our industrial productiveness. It is needless and perhaps it will be harmful, to discuss the half dozen reasons given for this almost total abstention. Admitting all these reasons as facts of actual influence, the general resultant and sum total of them comes simply to this, that we consider ourselves to be so specially superior people that there is no need for us to enter into the comity of nations. It is a question of degree. I admit that we are superior; I regret that I cannot believe that we are so extraordinarily superior that this sort of thing is safe. I am filled with grave and painful apprehension that only a short delay will suffice to prove that this abstention on the part of British manufacturers from co-operation in what was the greatest effort yet made in history to demonstrate the solidarity of civilised nations, and what has been a magnificently brilliant success in this noble purpose, that our abstention has been the big-

gest mistake made these many years by the English people."

Professor Smith gives utterance to some significant words as to the future of the Chinese nation under reformed conditions, so far as technical and commercial conditions are concerned.

"In twenty, or thirty, or forty years from now, the pressure of competition will be far greater than anything to be felt in the more immediate future, because by that time, or not much later, China, under a reformed government, will be rejuvenated as Japan has been in these last three decades, and there will enter into the arena of the world's workshops the gigantic strength in numbers of the population, in natural resources of the soil, in the intelligence and hand-skill and patient laborious industry of the people, in the high intellectual quality of the cultured classes, of a brilliant civilisation, many thousands of years old, resting on the solid basis of a commercial and family morality, and of social philosophy of the finest quality.

"The philosophy of the ancient civilisation of China, which she will never abandon, in spite of temporary outbursts of violence like the present, is founded on peace and peaceful methods. It will be a struggle of wits and dexterity, not one of thunder and blunderbuss. Chinese diplomatists will fight with the weapons of reason, persuasion, urbanity and moderation. We will lose, unless we adopt the same weapons and practice to become skilful in their use."

Standardisation in Manufactures.

So much has been said about the advantages of standardisation in connection with supremacy in manufacturing, that a thoughtful editorial in a recent issue of *Engineering* is especially timely.

Standardisation is practically divided into two varieties, the particular and the general, the former pertaining to a given workshop, the latter to the whole or a portion of an industry.

In the first class naturally the conspicuous successes are found in the manufacture of patented articles of assured utility, such as the Westinghouse brake or the Willans engine, cases in which the customer must take what the manufacturer offers, there being no occasion or opportunity for modifi-

cation for individual orders. The attempt to introduce such methods in a general establishment, competing for business in the open market, is altogether a different matter, demanding great courage, a stubborn will, and much constructive ability.

"To obtain either high quality or cheapness of output there must be a generous use of capital. When both are to be combined, the outlay must be still greater. If quality depended on design only, it might, in some cases, be obtained at small cost, when the head of the firm undertakes the work himself. But as business is now conducted, a great deal is required for successful manufacture beside a drawing-board and a supply of paper. There must be capable management in every department, from the first to the last, and this always commands its price. Further, the most modern and the best machinery must be employed, and much of this must be constructed for a certain end, and will of necessity be of little value for other work. It, therefore, follows that the man who would go in for standardised manufacture must lay out his works for the purpose; that is, he must stake his money on an attempt to create a special trade, with the knowledge that he may very easily lose a considerable proportion of it. Year by year it becomes increasingly difficult to develop gradually this kind of manufacture. Unless help can be gained from patents, the plunge has to be made boldly. The greater the courage, the larger the chance of success, provided always that it is associated with constructive ability and business acumen. A great business can never be made out of a poor article, although it may be realised in spite of high prices, if the goods are of sufficiently high quality. The road to success, however, lies in turning out the best goods at a moderate cost, and it is easy to understand that the route is never crowded with passengers."

General standardisation is altogether different, and is best exemplified in its most notable instance of the Whitworth screw-thread system, an example which might well stimulate imitation in the case of the pitch of change wheels, and many other obvious cases.

A great obstacle to this kind of standardisation is the consulting engineer, who dearly loves to have his individuality impressed

upon his work, even though it may not be to the customer's advantage, either in cost or utility. In fact the progress which has already been made in general standardisation has gone forward with the decline of the prestige of the consulting engineer. In the United States, where the consulting engineer has never had the influence of the profession in Great Britain, and has generally conducted work on a broader scheme, leaving details to the best practice of the manufacturer, standardisation has reached its highest pitch.

"In regard to particular standardisation, the consulting engineer in America is in general content to specify his requirements, and then to choose from among competing designs that which suits them the best. He treats manufacturers as men, leaving them to arrange the details of their business, while here they are often treated as children who must never be left for a moment free from control, lest they get into mischief. Standardisation of all kinds is the fruit of a broad and liberal spirit, which looks to ends rather than means. It is the realisation of the idea that the interests of the units are identical with the interests of the community, and that he who serves his customers, or clients, best, is most likely to further his own ends."

Modern Rolling Mills.

AMONG the papers presented at the recent meeting of the Iron and Steel Institute, that by Mr. Louis Katona, containing suggestions for the improvement of rolling mills, has attracted attention.

Mr. Katona gives a general history of the development of the modern rolling mill, showing how there are at present three types of mills in use, viz., pull-over, or two-high, non-reversing mills with fly wheels; three-high mills, with fly wheels; and two-high reversing mills.

In all of these certain defects appear, which are enumerated in the paper at length, but which can only be touched upon briefly here. The principal opportunities for improvement are with the consumption of power, and the waste of fuel and material. The object of the rolling mill is to reduce and control the cross section of the material, and this legitimately consumes a definite amount of power. Far more power

is used, however, than is actually returned in the form of useful work effected in reducing the section of the material, and the problem is to reduce the ratio between the total amount of power consumed and that actually utilised.

The great defect of the present system of rolling-mill plant lies in the enormous masses that have to be set in motion to no effect. At any moment the only part of the mill which does useful work is the particular groove through which the metal is passing. All the power consumed in driving the rest of the mill is so much wasted energy. This includes all the power expended in the idle rolls, the couplings, the gearing, and in the fly wheel used in two and three high rolls."

It is not only the idle masses, but also the idle time, which forms a source of loss; the consumption of power when no effective work is being done continuing for more than 90 per cent. of the total running, according to observations of Mr. Katona. Besides these main sources of loss there are a number of minor ones which make up an important aggregate.

Without going too fully into the proposed improvements, for which reference must be had to the original paper, their general nature may be indicated.

Instead of using long rolls, with a number of passes in each, it is proposed to have a separate pair of rolls for each groove, the rolls thus being shortened axially so as to become mere disks. By placing a number of such mills side by side the passes may be made alternately back and forth, so that the whole series of grooves may be employed a far greater proportion of the time than when a number must be idle.

This system lends itself admirably to electric driving, enabling much of the resistance of heavy transmission gear to be avoided, while the load upon the engines may be more nearly equalised. It would also be possible under this system to work a part or the whole of the plant, as the demands of the market indicate, a far greater flexibility being attained.

Mr. Katona enumerates many advantages which he claims will result from the adoption of his system, and it is to be hoped that an early opportunity will be afforded of demonstrating its success in actual service.



REVIEW OF THE CONTINENTAL PRESS

Power-Gas Generation.

THE general attention which is being given to gaseous fuel at the present time is reflected in the number and extent of articles in the current technical press, and there are numerous discussions of natural gas, blast-furnace gas, producer gas, and other varieties for use both as a furnace fuel and as a source of supply for internal combustion motors. Among these papers is a valuable comparison of water gas and other combustible gases, by the well-known engineer, Herr Johann Körting, of Hanover, in recent issues of the *Zeitschrift des Vereines Deutscher Ingenieure*, from which some abstracts are given.

Herr Körting emphasises the fact that there is often confusion in speaking of various kinds of fuel gas, and that water gas is not infrequently confounded with Dowson or other producer gas, and so he is careful to note the distinction in chemical composition, as well as in the methods of making.

The difference between the two gases will plainly be seen upon examining the chemical composition. Producer gas, being generated by the incomplete combustion of carbon in the form of coal, coke, or other fuel, is composed principally of nitrogen and carbon monoxide, there being from 23 to 30 per cent. of carbon monoxide, 50 to 65 per cent. of nitrogen, with a little carbon dioxide and hydrogen. Water gas, on the contrary, being made by passing steam through incandescent coke or other fuel, contains a much larger proportion of hydrogen, the proportions ranging about 40 per cent. carbon monoxide, 50 per cent. hydrogen, 3 to 6 per cent. nitrogen, with a little carbon dioxide and marsh gas. The superior calorific value of the latter is apparent, and the commercial difference must therefore be mainly one of the cost of generation.

When the lean gas, as producer gas has often been called, can be obtained as a by-product, as in the case of blast-furnace gas, or by the use of inferior grades of fuel, as

is the case in some of the more recently devised forms of producers, its low cost renders it available, especially for use in internal combustion motors, where a slight increase in size of motor, and an elevation of the cylinder compression will render equal power and higher efficiency possible over illuminating or other fuels. In other instances it may be found advantageous to generate the richer water gas, especially in view of the recent advances which have been made in the process.

The original process of making water gas consisted in using a cylindrical producer filled with coke, this being raised to incandescence by an air blast from beneath, steam being passed through the coke after a full incandescence had been secured. As the coke became cooled the steam was turned off and the air blast renewed, and so the operation continued intermittently. This process naturally consumed a large portion of the coke, thus carrying away a large percentage of the calorific value of the fuel, and in spite of attempts to utilise the heat thus generated, either under boilers or in connection with regenerators, only about 40 per cent. of the calorific value of the coke appeared in the resulting gas.

Two processes have been devised which enable a higher efficiency than this to be obtained, namely the Dellwik-Fleischer and the Strache. The latter is intended to use any kind of fuel, usually coal or a mixture of coal and coke, the coal being coked in the course of the blow, the resulting producer gas passing through a regenerator which serves to increase the efficiency by conserving a portion of the heat which would otherwise be carried away. The system thus produces both water gas and producer gas, and as these are delivered separately they can be applied to appropriate uses; the producer gas may be considered as a by-product of the water gas generator.

The Dellwik-Fleischer system generates no producer gas, but aims to burn the fuel,

coke or non-bituminous coal completely to carbon dioxide, and thus utilise the greater heat developed for the decomposition of the steam. Since 1 kilogramme of carbon burned to carbon monoxide generates only 2,442 calories, while 8,080 calories are evolved by its combustion to carbon dioxide, it is evident that a higher efficiency will be secured by completing the combustion. This Dellwik accomplishes by using a much less depth of fuel in the producer, together with side charging apertures which enable the fuel bed to be maintained at a constant depth. The air pressure is also controlled so as to effect the desired combustion, and thus the full available amount of heat is obtained.

The result is an efficiency of about 75 to 80 per cent. instead of 40 to 45 per cent., and thus water gas is made available commercially where formerly the cost was prohibitory.

Herr Körting also discusses the cost and efficiency of coal gas, and finally tabulates the various commercial combustible gases, giving their relative thermal values, both from laboratory tests and from the working of existing plants, with the costs both of given volumes of gas and of thermal values resulting. The original paper must be consulted for details, but the general conclusions are as follows:

When the plant is to be used only for power generation, producer gas will not be replaced by any of the others, since it gives a more complete utilisation of the fuel, less expensive operating force, and a cheaper original plant. When high temperatures are to be produced, however, water gas holds the first place, and for many uses cannot be excelled. Especially by preheating the air blast the temperatures may be materially increased.

Herr Körting gives coal gas the precedence for illuminating purposes except in certain cases when he advocates carburetted water-gas, but his conclusions in that direction are not pertinent to the question of power generation or manufacturing purposes.

A Study of Induction Jets.

THE action of a stream to produce a current in another fluid with which it is brought in contact is a fact known and util-

ised in many ways and from an early period, but it is only within recent years that the theoretical and practical knowledge of this action has been perfected.

The Giffard injector was the precursor of a number of devices in which steam is employed to impel water, and similar jet apparatus is used with air acting on air, air on water, water on water, etc.

Much of the information regarding the principles involved in these devices has been kept secluded in the possession of the makers, being considered as the results of private investigation, and valuable as trade property, but we now have, in the paper of M. A. Rateau, in a recent issue of the *Revue de Mécanique*, a full theoretical treatment, which appears to harmonise well with the results of many experiments, and which should reduce the general design of such jet devices to a rational basis, removed from the domain of empiricism.

The importance of such devices is generally admitted; they extend from the minute atomizer to the great annular induction jet which forms the essential feature of the new Saccardo ventilating apparatus at the St. Gothard tunnel, with every variety of construction and dimensions between.

It is impracticable here to give the mathematical discussion of M. Rateau; for that the reader must be referred to the original paper, but some of his conclusions, and the results of his experiments, may be given. It may here be noted, however, that for his work in this direction M. Rateau has been awarded the Fournayron prize by the Académie des Sciences.

Jet devices are composed of three distinct parts, developed to a greater or less degree in various forms: the converging tubes, or jets proper; the mixing tube, and the diffusing tube. In the first the impelling and impelled fluids are delivered, one jet usually being annular in form and encircling the other; in the second, usually a short, nearly straight tube, the two fluids unite and are mingled more or less completely; in the third the total velocity of the current issuing from the mixing tube is diminished, and partially converted into useful pressure. The diffuser is generally divergent, and separated from the mixing tube by a contracted portion, called the neck, but in many instances, as, for example, the blast nozzle

of a locomotive, the parts are not clearly defined in appearance, although existing in fact. In some forms, as in the Körting ejector, the mixing portion is composed of several successive cones, and many of the special features at first apparent in different forms of jet apparatus will be found reducible to the above three elements.

In his theoretical treatment M. Rateau confines himself to fluids which, although possibly of different densities, do not change their density during their passage through the apparatus, thus omitting steam injectors, in which the condensation of the steam makes an enormous difference in the density, because of condensation. This branch of the subject, being involved with the important question of the flow of vapors, is reserved for a later treatment.

The whole question is one of the relations of velocities to pressures, and in the formulas developed the object is to take the initial velocity of the entering jet and the mass of fluid in motion, and deduce the resultant issuing velocity, mass, and pressure.

This M. Rateau has done in a very complete manner, and he shows that in many instances the results from existing apparatus are by no means what might be attained. At the same time he shows the limitations of such devices under existing operative conditions.

According to the theory of M. Rateau, it is impossible to obtain with such devices an efficiency of more than 40 per cent., and in practice it is unusual to secure more than 25 per cent. This is largely due to a fact which has not been sufficiently appreciated, that the action of the diffuser is imperfect, rarely attaining 85 per cent. If it were possible to attain a complete efficiency of the diffuser the total efficiency of the whole apparatus would be much higher.

The experimental portion of the paper gives plotted curves of experiments made upon eleven different forms of induction jet devices, showing the general close approximation of the curves to the parabola. From these curves the point of maximum efficiency is plainly seen, and is practically reached when the initial pressure of the inducing jet is four times that of the discharge of the mingled jets. In some cases

this ratio lies between four and five, varying with conditions of operation, but the former figure is more general.

The very thorough manner in which M. Rateau has worked out the theory of this interesting and practical problem causes us to express a desire that he may soon make public his researches upon steam jets, in which the condensation of the inducing fluid is an important element in the problem.

Modern Coke-Oven Systems.

In a recent issue of *Stahl und Eisen* some interesting comparisons are made of the development of by-product coke-ovens in Germany and other countries which may be noted here.

There are two principal designs in extensive use at the present time, the Semet-Solvay and the Otto systems, and it is to the progress of these that the article is mainly devoted. The growth of the by-product coke oven in recent years has been extensive. England and America are the exceptions, where the unscientific bee-hive oven still holds the pre-eminence, and but few modern ovens have been installed; but in nearly all other countries where coal is used the improved methods are making rapid progress, as, for example, in Russia, Italy, Spain, Japan, and China. The only reasons which appear to act against improvement are lack either of space or of capital.

The general principles of the by-product coke oven are well known, the coal being coked in chambers to which the heat is communicated through thin walls, while the heavy outer and division walls retain sufficient heat to prevent cooling during charging. The gases which are given off can be condensed and washed, and the liquid products also collected and separated into numerous commercial articles.

Differences in details of construction distinguish the various styles of by-product ovens, especially with regard to charging the coal, removing the coke, and applying the heat, the process being continuous, and mechanical handling being resorted to as much as possible. The heat in the escaping gases utilised for steam making by placing the steam boilers in the path leading to the chimney. A portion of the gas produced in the coking is used for heating; in the

Semet-Solvay system it is found that only about one-fourth of the gas is required for this purpose; and the interest in the application of blast-furnace gases to internal combustion motors has led to the proposal to use the richer coke oven gas also for motive power. This has been done successfully at Seraing, in Belgium, where one motor of 8 horse power has been running for some time, and two others of 20 h. p. each are under erection. The gas has a thermal value of 4,500 calories per cubic metre (about 500 B. T. U. per cubic foot) and about 0.8 cubic metre is required per horse power per hour. An interesting computation is given of the relative advantages of using the gas in gas engines and burning it under boilers. A battery of 25 ovens, producing 40,000 cubic metres of gas in 24 hours, would enable 520 h. p. to be developed in gas engines, while if burned under steam boilers the same fuel would generate only 316 h. p.

Since the introduction of the first of these ovens at Havré, in Belgium, in 1883, there have been built down to the close of 1898 1,451 ovens, which, with the 357 since under construction, brings the total up to 1,808, the locations and details of these being tabulated in the above article.

This development of by-product coke ovens is but one example of the growing tendency towards the reduction in wastes which is making itself felt in all lines of industry. In a great number of establishments valuable by-products, either tangible or intangible, are wasted when they might be converted into value and made to yield a continuous revenue. It is one of the functions of the engineer to develop methods for utilising waste wherever possible, and the pressure of modern competition is rendering such methods more necessary than ever before.

The Efficiency of Express Locomotives.

WITH the increasing use of high-speed trains, the question of the actual cost of increased speed as compared with increased income is being earnestly discussed on both sides of the Atlantic, and while all the elements of cost must necessarily be taken into account, those relating to the action of the locomotive itself appear to attract the most interest. In a recent issue of the

Zeitschrift des Oesterr. Ingenieur und Architekten Vereines is a paper upon this subject by Herr Rolf Sanzin, and his treatment of it is especially interesting, because he examines it in view of the shortcomings of the express service of central Europe, showing in what directions steps toward improvement must be made.

The principal conditions to be fulfilled by the modern express locomotives are prompt starting, maintenance of a determinate speed for a given load and inclination of track, and capability of being quickly stopped. The first condition is met by providing sufficient boiler capacity, and also by insuring sufficient adhesion upon the rails for the driving wheels. The latter is a fundamental element in the design of the locomotive, by which the weight upon the drivers is predetermined, while slippage at starting can be largely prevented by the use of suitable sanding devices. It is also affected by the ratio between cylinder diameter and driving wheels of high-speed engines from an only within narrow limits, the larger driving wheels of high-speed engines form an obstacle to prompt starting, unless this point is well considered.

The maintenance of speed upon the road depends mainly upon the boiler capacity. When the maximum speed is stated, it is not sufficient that this be maintained upon level stretches and down grades; it must also be attained on moderate up-grades.

The control of stops is necessarily an important element in high speed running, the time used in slowing down being thus materially reduced. With this and the other two essentials must be included well constructed permanent way, with heavy rails, good ballasting, and an efficient system of signalling.

In examining the extent to which these requirements are met by the railways of central Europe, Herr Sanzin compares the speeds of trains with those of England, France, and the United States, and shows that there is manifest room for improvement. In central Europe the maximum speeds are 50 to 55 miles per hour, and these are not generally attained, while in France, England, and America the maximum speeds reach 75 to 85 miles. A part of this superiority is due to better roadbed, heavier rails, and lighter grades, but the

room for improvement in motive power is also apparent. Especially important is it that the trains should be equipped with automatic brakes of modern type, many of the continental roads being fitted now with non-automatic vacuum brakes only.

Herr Sanzin gives a number of diagrams showing the relative efficiencies of various types of locomotives, hauling trains of given weights at different speeds under varying conditions of grade, details of the engines being also fully given. For central Europe the question of grade is important, and hence especial attention is given to the limits of incline which are shown to be necessary for various speeds. Generally speaking, the maximum speed can only be attained on down grades when that maximum reaches or exceeds 75 miles per hour, and under these circumstances the maximum is about 20 per cent. higher than the mean speed. The gain by making great speed on down grades offsets to a great extent the loss due to ascending grades. This is one reason why the single-driver engine still finds favor in England, and why higher average speeds are there attained by its use than are secured by coupled locomotives in central Europe. The great problem is to maintain the highest possible average speed with but a moderate maximum speed, and this can only be done by the careful observance of all the details.

It is especially important to take advantage of the long continuous runs, and the maximum speed should be utilised wherever possible in the arrangement of the time schedule.

A most important element is the right choice of locomotives. Since the engine must be capable of coping with the ascending grades without material loss of speed, great power is required, while at the same time the ability to make high speed upon levels and down grades must not be impeded by the moving parts. These qualities, for service in central Europe, appear to be best attained by providing large boiler capacity, ample cylinder dimensions, driving wheels of moderate diameter, with a maximum weight on the drivers. Such an engine, while possibly not capable of giving the greatest maximum speed, is well adapted for the greatest average speed in a varying country under the severe conditions.

Lean Gas as a Source of Motive Power.

AMONG the various articles in recent technical literature, relating to the employment of gas as a source of motive power, there is worthy of especial notice a paper by M. Charles Thonet, in the *Revue Universelle des Mines*.

In discussing the subject M. Thonet devotes a moderate space to a description of the gas producers used in Switzerland and Belgium, these being simple, and not greatly different from those well-known in other countries. The gas produced is mainly composed of carbon monoxide and nitrogen, generated by delivering an insufficient quantity of air for complete combustion through a deep bed of coal in a cylindrical generator. The use of a small steam jet adds to the product of gas and gives a mixed gas partially resembling water-gas, although not so rich, while much less expensive. The composition is about 20 per cent. each of hydrogen and carbon monoxide, and 50 per cent. nitrogen, the balance being carbon dioxide and hydrocarbons; the calorific power being 1,200 to 1,300 calories per cubic metre (135 to 145 B. T. U. per cubic foot). A detailed description is given of the Fichet & Fleurtey apparatus, this including scrubbers and purifiers for the mixed gas.

The principal feature discussed by M. Thonet, however, is the applicability of gas-power driving to electric stations, and comparative data are given of several French and Swiss stations, showing the marked economy of gas power over steam in many instances, especially for moderate powers.

In electric-station work the peculiar conditions must be considered, and an examination of the installation at Orleans is given as a successful example. The gas engines are of the Crossley type, with two opposing cylinders, 165 h. p. being developed by each engine, at a speed of 180 revolutions. The flywheels weigh 9 tons. The essential feature for the economical working of gas motors is that the load should vary but little, hence for such irregular loading as is found in tramway stations accumulators should be employed as equalisers. At Orleans the plant consists of two engines, each with a direct-connected dynamo, the connection being made in each case with

the Raffard coupling, consisting of two discs with projecting pins interlaced with a hemp rope. There is also a battery of accumulators, a Pirani regulator and a switch-board. The Pirani regulator is composed of two dynamos placed upon the same frame, and connected so that one acts as a generator and the other as a motor. Being placed between the main dynamos and the accumulator, they are so arranged that when the work demanded by the line corresponds to the normal load the battery neither receives nor gives out current. If at any moment there is a surplus of current the regulator adds its effect to that of the dynamos to charge the battery. If, on the contrary, the demand of the line is greater than the capacity of the dynamos, the regulator contributes, with the accumulator, to supply the line. A special rheostat enables the action to be regulated once for all. With such arrangements as adopted at Orleans the gas engines operate constantly at a load which is practically uniform, and a high degree of economy is obtained.

M Thonet gives a table comparing the cost in coal per h. p. hour and also in actual expenditure, using for this purpose the data for steam engines obtained by M. Lanhoffner at Zürich, and assuming the price of coal at Zürich in all cases. For condensing steam engines of 200 to 500 h. p. the coal consumption may safely be taken at 2.5 to 1.5 kilogrammes (5.5 to 3.3 pounds) per kilowatt-hour, or 1.8 to 1 kilogramme (4 to 2.2 pounds) per effective horse power hour in actual working conditions. For gas engines under the same conditions, using lean producer gas of the mixed kind above described, the fuel consumption ranged from 0.65 to 0.6 kilogrammes (1.3 to 1.4 pounds) of coal per h. p. hour. Taking the cost of coal at Zürich at 32 francs per ton this works out at 0.048 franc per effective horsepower hour for a condensing steam engine, and 0.019 franc for the gas motor, the latter being less than 40 per cent. of the former.

The general comparison of the figures for the stations of Orleans, Zürich, Lausanne, and elsewhere, as discussed by M. Thonet, shows conclusively that, especially for stations of moderate size, the gas motor needs only proper conditions of installation and operation to be vastly more economical than steam power.

The Barmen-Elberfeld Railway.

THIS interesting single-rail line has been already referred to in these columns, but on the occasion of the recent formal opening of the completed section by the German Emperor, the *Zeitschrift des Vereines Deutscher Ingenieure* gives a very complete account of the whole system, which well deserves some further notice.

The line is situated in the narrow Wupper valley, which is in some places only 500 yards wide, and where the industrial cities of Barmen, Elberfeld and Vohwinkel have developed so that they form practically one community; and, although there is a steam railroad running through the valley, and also an electric railway system, the demand for increased rapid transit facilities became so great a few years ago that the cities found it necessary to build a new road.

An ordinary elevated railroad was at first thought of, but, as the conditions in the Wupper valley were peculiarly favorable for a suspended railway, the Langen monorail system, which had proved successful on an experimental road at Deutz, was finally chosen.

The crowded condition of the valley made it advisable to build the road right over the river for a greater part of the distance. The total length of the line, when completed, will be 13.3 kilometers, about 10.5 kilometers of which follows the stream from the upper end of Barmen to a point near the boundary between Elberfeld and Vohwinkel, where the Wupper makes a sharp bend. From this point the line runs along the streets of Vohwinkel to its lower terminal loop. Although the general location of the road was thus determined at the start, the detailed plan was fixed by the requirement of keeping the curvature on the main line as far as possible within a minimum radius of 90 meters, there being only two curves which have a radius of 75 meters. Tangents and curves are connected by cubical parabolic transition curves 50 meters in length.

This curvature was based upon the results obtained on three different experimental roads at Deutz; and since the completion of the Elberfeld section the experiments have been continued on a larger scale, and the earlier results confirmed. The cars run with a smoothness not hitherto at-

tained, and at curves, particularly, it is found that passengers are almost completely free from any jolting. Above all, on account of the free suspension of the cars, which permits them to assume a greater inclination from the vertical than those on ordinary roads, a much higher speed can be maintained on curves. Under ordinary circumstances, a speed of 30 kilometers per hour would be the highest permissible on 90 meter curves, while on the Elberfeld road 50 kilometers per hour is perfectly feasible. As the average interval between stations is only 700 meters, this speed is about the economical limiting one. The structure of the Elberfeld road is designed so as to permit the cars to swing out at an inclination of 15° , but on the experimental road at Dentz, on $9\frac{1}{2}$ meter curves, cars were inclined at an angle of 25° without the occupants being at all aware of their peculiar position, the shades on the windows having been drawn down.

The Wupper falls 25 meters in the 10.5 kilometers, for which it runs under the suspended road, and the grade of the latter is, in general, parallel with the surface of the stream. The height of the road varies somewhat, however, as it has to be increased at some street crossings and bridges, and is made as low as possible at stations. When the line leaves the river it ascends a nearly uniform grade, rising about 48 meters in 2.8 kilometers, the steepest inclination being 1 to 37. On the sidings, however, there are grades as high as 1 to 22.

The lower edge of the cars is 3.5 meters below the top of the rail, and as the car must clear the street by 4.5 meters, the rail must be at least 8 meters above street level.

There are 20 stations on the line, the interval between them varying from 320 to 1,000 meters. At the terminal stations there are loops, so that the trains can circulate continuously up and down the main line, which is double track, without switching. The heaviest traffic will be in Barmen and Elberfeld, so that only some of the trains will run all the way to Vohwinkel. There is, therefore, an intermediate loop, passing under the main tracks, at the lower end of Elberfeld, to accommodate the trains which run only in that city and Barmen.

The road is carried by trusses of special design, with spans varying from 33 to 21

meters. On the river section the trusses rest on plate girders connecting the upper ends of inclined latticed columns, which abut against masonry foundations in the banks, while over the highways the trusses are supported on plate girder arches continuous with plate columns. The rails are carried on the outer part of the lower chords, with an interposing layer of felt to prevent shock and noise.

The weight of the trusses varies from 580 kilograms per meter (390 pounds per foot) for the 21 meter spans, to 786 kilograms per meter (528 pounds per foot) for the 33 meter spans, while only 142 kilograms per meter (95 pounds per foot) has to be added for tracks and flooring. The average weight of the whole structure, including the columns, is about 1,100 kilograms per meter (740 pounds per foot), the river and highway sections agreeing very well in this respect. The rails are T-section, 15 meters long, and weigh 24 kilograms per meter (16 pounds per foot). The weight of the whole superstructure is 31 kilograms per meter (21 pounds per foot).

As the car-wheels are double-flanged, the switches have to be of peculiar construction. The main track is continuous throughout the line, and at switches the point gradually rises to an elevation of 75 millimeters above the through rail, so that the wheel flanges will clear the latter. The track curvature at switch points has a radius of 8 meters, and the sidings, which are situated at the loops and terminals, drop below the level of the main track.

At stations the tracks and platforms are completely roofed over, and among the special features is a beam running along outside the edge of the platform, with a surface corresponding with the under body of the cars. A spring on the car slides along this beam and prevents any rocking while passengers are entering and leaving.

The total weight of metal used in the construction of the whole road, including stations and car-houses, is 18,000 metric tons (20,000 short tons). The cars are suspended from two trucks, 8 meters apart, each with two wheels. The heavy hook-shaped frames connecting the trucks and cars embrace the track-supporting beams in such a way that, with the deep wheel flanges, derailment is impossible, but so as

to permit the cars to swing 15° from the vertical.

On each truck is an electric motor, which drives both wheels. Current is taken from a light rail by means of a sliding shoe. When two or more cars are coupled together, all the motors are controlled from the first car, which alone has its sliding shoes in contact with the conducting rail. The current in this case is led to the other cars through connecting flexible cables.

The cars are provided with Westinghouse air brakes, which are used in ordinary operation, the compressed-air tanks being filled at the terminal stations. The motors are used for electric braking when beginning to slow down before stations, and in case of emergency there are also hand brakes.

An automatic electric block-signal system is in operation, the necessary contacts being made by the trains themselves. The signals are red and green electric lights, which are used by day as well as by night. At present the 4.5-kilometer Elberfeld section is in operation, the 3-kilometer Vohwinkel section will be opened in the course of the coming winter, while the 6-kilometer Barmen section will probably not be completed before 1902.

Rescue Apparatus in Mining.

WHENEVER explosions occur in mines or tunnels, or noxious gases make their appearance, it becomes of pressing importance to enter the dangerous regions at once and rescue any persons who may have been injured or overcome, and also to repair damages and take measures to prevent further trouble. It is necessary, of course, to provide anybody entering such a mine with a supply of fresh air, or oxygen, and a recent number of the *Oesterreichische Zeitschrift für Berg-und Hüttenwesen* contains a review, by General Johann von Lauer, of various forms of respiratory ap-

paratus which have been used, particularly in military mining.

In some of the earlier forms, a cylinder of compressed air was carried on the miner's back, the air being led through a regulating valve and tube to a hood which completely covered the miner's head, and, in some cases, extended to his waist. This hood, or mask, had eye-holes covered with glass, and a valve to permit the escape of the exhaled air. In a modification of this apparatus two air tanks were carried on a two-wheeled barrow, one to supply air for breathing, the other air for a lamp or candle. At the same time, the barrow could be used to carry out disabled persons.

These earlier forms, however, had the disadvantage of furnishing only a very limited supply of air, unless air reservoirs were made large and cumbersome, and in the more recent apparatus the tanks have been entirely dispensed with, and air is pumped to the miner from outside through a long tube, very much in the same way that air is supplied to divers. A plate fits over the mouth, and is provided with rubber cushions which can be inflated so as to press firmly against the face and prevent any ingress of noxious gases. The air tube passes through this plate, and all the breathing is done through the mouth, the nostrils being clamped shut. A valve allows the escape of exhaled air. If gases or vapors injurious to the eyes are present, air-tight goggles are used.

Light is supplied by an electric incandescent lamp, fed with current through a thin silk cable. The source of current may be either a dynamo, or, preferably, a portable primary battery. The battery box has attached to it an electric bell, on which signals are rung by the miner by means of a key inserted in the lighting circuit and carried on his belt.

This last described apparatus has proven very successful in military mining, and experience with it has shown that no essential modifications are necessary.



Steam Engineering in the American Navy.

THE report of Rear-Admiral Melville, Engineer-in-Chief of the United States Navy, forms a most interesting and valuable document, and no excuse is necessary for copious extracts from so important a public paper.

A large portion of the report is naturally devoted to routine business and to statements of the operation of the current work of the Bureau of Steam Engineering, but with this are important recommendations and discussion of future policy. One of the most important problems before such a department is the necessity for keeping abreast with the march of improvement, while at the same time avoiding experimental innovations which might possibly hamper the efficiency of the service or possibly cripple it in time of emergency.

"One point in particular will illustrate the extreme value of high professional criticism in design. Some years ago the Department was urged, with no little pressure, to adopt the Belleville water-tube boiler as a standard for the new ships. This Bureau opposed the innovation wholly upon a close examination of the designs, criticising the very defective features which in later years have made conspicuous the comparative inefficiency of this type over the purely straight-tube, non screw-joint type for which I have given continuous and urgent preference. The Department is to be congratulated upon escape from this "pressure" and upon the conservative approval it has given to the change in the boilers of naval ships. Instead of having been encumbered during the last war with ships powered with a type of boiler necessitating a specially trained force even for its safe operation, the most effective vessels had either retained the Scotch boiler or possessed the simple straight-tube Babcock & Wilcox boiler and remained free from any real danger of becoming 'hors du combat' by reason of lack of a completely experienced fire-room man-

agement, or the sudden failure of delicate or intricate special apparatus connected with the steam generators.

"In many other details, difficult to make clear without purely technical description, has the Bureau prevented the incorporation of faulty features in design and has advanced the proportional perfection of machinery."

There has been active work upon various problems in steam engineering which needs to be supplemented by experimental demonstration, not so much to confirm the accuracy of the conclusions as to determine proportions and practical details. One of the most important of these problems is in connection with a radical change from the present standard for cylinder ratios in multiple-expansion engines, a subject which has also received much attention in stationary practice. Engineers in all departments of practice would welcome the results of such experiments and join in urging that they be conducted.

The great advantages of the presence of a repair ship with a fleet were demonstrated by the work of the *Vulcan* during the Spanish-American war, and the reverse experience has been had in Eastern waters in the absence of such a vessel. The repair work done at Manila and Hongkong has been so unsatisfactory that Admiral Melville is fully justified in his recommendation that a special repair ship be built and equipped. With the experience gained on the *Vulcan* it is possible to plan the requirements of such a vessel very fully, and it is to be hoped that this recommendation may speedily be executed.

The efforts of those interested in the assumed superiority of the line over the staff officers under the old rule, to effect a consolidation of the bureaus of Construction and Repair, Steam Engineering, and Equipment, into one Bureau of Ships, this new Bureau, of course, to be dominated by a line officer, meets with some telling strict-

ures from Admiral Melville. After showing that the whole tendency of modern work is toward specialization rather than to centralization, he pertinently remarks that there is already such a Bureau of Ships, but that it is really the whole Navy Department, and that its Chief is the Secretary of the Navy. The present arrangement, whereby the Secretary of the Navy is advised by the Board of Construction, has proved eminently satisfactory, except to those who view with dissatisfaction the necessarily increasing importance of the Engineer Corps, and there is no valid reason whatever for the proposed change.

So far as the operation of the personnel bill is concerned, it is only what might have been expected under the present influences. Not until the line officers, below navigators, are given as much duty in the engine room as on deck, will the true meaning of that bill be appreciated, and the spirit which seeks to avoid such an obvious duty utters its own condemnation. The younger line officers should be assigned as understudies and assistants to the experienced engineers now in charge of engineering work. In other words, it is most important that the fact should be realized that a modern fleet is a vast aggregation of machinery, and that it should be run by engineers and not by sailors. Sea power is too important a factor in national existence to be hampered by the old-fogysm which retains obsolete training in so-called seamanship and neglects the true basis of modern fleets, the fighting machinery. In recommending the detail of a modern vessel for a practice ship at the Naval Academy, Admiral Melville says:

"It seems to me that some of the time still devoted by the Academy cadets to seamanship, in the original sense of the term, may be wisely sacrificed to steam engineering, and that anomalous vessels for practice cruises can be safely exchanged for a modern type of war ship. Smokestacks have replaced topsails and top-hamper, and the officer of the deck finds more need of skill in quick manœuvre than in handling canvas aloft."

In discussing the difference between the work of a naval machinist and a naval engineer, Admiral Melville gives an excellent description of what the naval engineer

should be, and what he must be if the navy is to keep pace with the development with the conditions in which it is now called to act.

"The naval engineer of to-day must be one not only specially qualified by aptitude for his profession, and secure in a thorough technical education, in which the theories governing his later work are firmly implanted in his mind, but he must also have had actual practical experience in the different mechanical branches of his calling, gained in such a favored way as to give him intimate knowledge of the prevailing methods of work without inflicting that long apprenticeship which binds the ordinary mechanic who must pay for his training by his actual output, and whose future employment must greatly depend on manual skill. Thus years are saved in the progress possible, and extensive knowledge of designs, with immediate practice in the embodiment of these in actual work, is obtained. Thence comes the experience gained on shipboard with machinery under all conditions of service, and the observations of the machinery of foreign ships and the work at ship-building establishments ashore. These experiences are only obtainable, in their full extent, by the naval officer, to whom every courtesy is extended by his professional brethren at home and abroad. Both his position aboard ship and his comparative freedom from confining detail work enables the naval engineer to broaden his professional education by the comparison of the designs and operation of machinery of different classes of ships. It also permits him to keep posted in advanced shop practice and in current engineering literature, thereby enabling him to keep out of the 'hide-binding' grooves worn by a narrower class. So much is necessary to continually study and apply, as to make a leading position in this profession only possible to one with exceptional opportunities and surroundings. Hence it is not lack of native ability, but environment and training, which precludes the possibility of simply advancing the machinist class to that of the efficient naval engineer."

Foundry Traveling Cranes.

In a paper recently presented before the Pittsburg Foundrymen's Association by Mr. A. D. Williams, some pertinent remarks are

made upon the use of electric traveling cranes for foundry service.

The general use of the multimotor electric crane at the present time renders it desirable to learn the practical points which have developed with the use of motors in the peculiar conditions of foundry service, and Mr. Williams evidently writes from the standpoint of the practical foundryman.

Apart from details of construction, which have become fairly well standardized and established, the most important matter is accessibility and ready removal of parts. Armatures and commutators, parts most liable to injury, should be capable of ready removal, as repairs can be much more readily made, and it is advisable to have spare parts which can be substituted, so that the service of the crane may not be interrupted.

An important feature in electric cranes, especially for foundry service, is the lowering gear. In the best forms of construction the brake is so arranged that the tendency of the load to run down acts to set the brake. In lowering, the motor acts against the tendency of the load to lock the brake, and the load cannot move until these two forces balance each other. This is a very safe device, and satisfactory when well made, but it sometimes acts in a jerky fashion, developing strains in the structure, and possibly damaging the mold.

The difficult conditions with which crane makers have to contend are often responsible for unsatisfactory forms of construction. In order to obtain the maximum amount of trolley travel a short trolley is demanded; the maximum amount of hoist requires that the trolley shall be placed close to the roof chords; and when these requirements have to be met in an old foundry, the ingenuity of the crane builder is often severely taxed.

In order to prevent overrunning, either in hoisting or in bridge travel, safety devices are often employed, but the utility is questionable, as they may usually be evaded by ingenious operators, and it is better to have the crane in charge of a responsible man, who will be careful at all times.

The usual provision for keeping the crane bridge square upon the tracks is by a so-called "squaring shaft" transmitting the power of the motor positively to both ends

of the bridge alike. It is hardly necessary to observe that this involves truck wheels of the same circumference, and it is also necessary that the shaft should be much larger than the mere working stresses indicate, as stiffness and rigidity are essential. In some of the earlier types the motor was placed at one end of this shaft, with the result that the torsion of the shaft caused the bridge to get out of square. By using a stiff shaft and placing the motor in the middle of its length, good results are secured.

The crane girders should be braced laterally, either by some form of lattice bracing, or by being made of the box type; the former is preferable, as the box girder cannot be painted inside. Provision should be made for climbing about the crane, as repairs are often delayed by the difficult position in which the men must work.

Mr. Williams calls attention to the importance of reinforcing the service of a traveling crane by providing a number of light jib or post cranes along the sides of the foundry, in order that the time of the heavy machine may not be wasted with small work while important matters are delayed. When a foundry is thus equipped it will be found that there is a great saving in labor, and a far greater output from the skilled men, to the manifest advantage of the whole establishment.

Heat and Power from Furnace Gases.

Now that there is no longer any doubt about the fact of the practical utilization of the discharge gases of blast furnaces for motive power, the subject begins to assume a quantitative, instead of a qualitative, aspect, and hence the paper of Mr. F. W. Gordon, in a recent issue of the *Iron Age*, is of much interest. Mr. Gordon takes up the question from the side of the thermal reactions, striking a balance between the thermal units supplied in the fuel, and those consumed in the reduction of the iron, the remainder being more or less available for the production of power, according to the efficiency of the process.

Taking data from earlier papers based upon investigations at South Chicago, made several years ago, Mr. Gordon assumes the consumption of 1,862 pounds of coke per ton of pig iron to be a fair quantity, and

proceeds to compute what amount of heat should be used by the furnace, and how much would remain available for other purposes.

Basing the completeness of the combustion upon the composition of the discharge gases, Mr. Gordon computes in detail that the total heat of the consumed gases is 7,889.93 B. T. U. Deducting from this the heat necessarily lost in chimney gases, radiation, and convection from stoves and boilers, the actual available heat is given as 5,986.74 B. T. U., this being an efficiency for the stoves and boilers of 75.75 per cent. Of this heat a certain amount is required by the furnace, and computations are given for the heat used for heating the blast, driving the blowing engines, hoisting the material, and pumping water, these items adding up a total of 2,220.94 B. T. U., leaving a balance of 3,765.8 B. T. U. that may be used elsewhere, and showing that only 37.1 per cent. is used by the furnace.

Mr. Gordon, in all his computations, assumes that the gases are burned under boilers to generate steam, and he proceeds to show the economies which may, in his opinion, be effected in this department.

In the case of a 300 ton blast furnace, the power not required by the furnace and available for other purposes is 4,223.8 horse power, and assuming engines consuming 1.8 pounds of coal per horse power hour, with coal at \$2.00 per ton, the fuel value of the waste gases is equal to \$61.095 per annum.

"The failure to derive any great advantage from the excess of heat in the blast furnace is due to lack of appreciation of its value. The subject has not been followed up. If furnace owners believed that with day and night use of the gas from a 300 ton furnace, coal at the rate mentioned could be saved, worth \$60,000 in one year, the subject would receive attention.

"That perhaps every engine in the steel plant can be run from the furnace boilers, together with the blowing engines, pumps, etc., of the furnace, while enough gas is diverted for heating the blast, will not be taken for granted. But with good combustion, ample stove surface, that their chimney gas may be kept at a low average temperature; with well-set boilers of ample surface, carefully tended and cleaned inside and outside; with blowing engines develop-

ing in compressed air the equivalent of 10 per cent. of the heat of the gases burned to raise the steam these engines consume, and with the surplus steam economically distributed and used, the total steam work of a steel plant may be done without burning any coal for steam, while the furnaces are working well."

If such results can be obtained with steam plant, the engines having a maximum thermal efficiency of only 15 per cent., what can be done with the direct use of the gas in internal combustion engines? This question is not discussed by Mr. Gordon, but it can easily be computed when it is realized that the thermal efficiency of the internal combustion engine for lean gas may safely be taken at 30 per cent., instead of the 15 per cent. efficiency of the steam engine.

Undoubtedly the iron and steel works of the future will have few or no steam engines. Gas-driven blowing engines will provide the blast; central power plants containing large gas engines directly connected to electric generators will provide light and power for distribution to all parts of the works; the rolling mills will be electrically driven, as will all the other machinery, and there will be a surplus for outside use which may yield a revenue as great as that obtainable from the iron manufactured.

The Reaction Breakwater.

THE subject of the improvement of the Southwest Pass of the mouth of the Mississippi was briefly mentioned in the last issue of the Magazine, with especial reference to the jetty system proposed by the government Board of Engineers.

Another plan, worthy of careful attention, is the so-called reaction breakwater, advocated by Professor Lewis M. Haupt, which appears to be especially well adapted to this important case. The reaction breakwater, the example of which at Aransas Pass has been fully discussed in these columns, is really a device to utilize the well-known tendency of a channel to hug the concave bank of a bend, the action of the curvature being to produce a scour due to the concentration of the currents. In a recent issue of the *Journal of the Franklin Institute* the applicability of this construction, long ably advocated by Professor Haupt, to the Southwest Pass, is discussed and some

interesting points brought out. The matter is also the subject of correspondence in recent issues of the *Engineering News*, in which the advantages of the single reaction jetty over the proposed pair of straight jetties of the government Board are emphasized.

Professor Haupt's plan, which has been elaborated with care for the particular case under consideration, involves the construction of a jetty starting from East Point and extending nearly 2 miles in almost a straight line parallel with the axis of flow and at a proper distance from it, thence curving to the westward with a radius of about 4.64 miles for a little more than 2 miles and ending at the 30-foot outer contour.

The portion of the area of discharge which would be cut out by this jetty is 115,750 square feet, or 66 per cent., which deducted from the total area would leave 59,375 square feet, or less than the normal section, but as the work would require several years to build and the volume of the movement would be confined to the overflow following the line of the jetty, the formation of the channel would be local, permanent and rapid. The 15,000 square feet of water section on the west flats would ultimately partially fill up and thus assist in confining the currents to the channel.

The inability of two straight, parallel jetties to create and maintain a deep channel is obvious upon the examination of the conditions, and this is practically admitted when it is proposed to supplement their action by dredging some 22,000,000 cubic yards of silt from the bar. The ultimate action of straight parallel jetties is to transfer the conditions to a point further out, recreating conditions at the mouth similar to those occurring in a state of nature. The jetties, acting as an aqueduct, must transport all the river sediment through the canalized channel and dump it into the sea at its mouth, and unless there is a strong littoral current the external forces are unable to distribute the material, and dredging must be constantly employed.

The single curved jetty, on the contrary, produces a reaction and scour across the entire bar, displacing the material in a lateral direction and depositing the silt on the

opposite bank of the channel, where it automatically forms a natural levee, adjusting itself to the regimen of the stream.

The correctness of this reasoning is demonstrated by the success which has attended the construction of such a curved breakwater at Aransas Pass, Texas. Here there is no stream to effect the scour, and dependence must be placed entirely upon the moderate current produced by the action of the tides. Notwithstanding this there has been produced in five years, without dredging, a continuous depth of 15 feet at mean low water, with maximum depths of 25 feet. The formation of a natural spit on the convex side of the breakwater effectually disposes of all question as to the permanency and stability of the structure, and although only partially completed, this example is a most conclusive demonstration of the correctness of the principle.

It is greatly to be desired that such a construction be given opportunity to show its action at the mouth of the Mississippi, and it is to be trusted that the plans of Professor Haupt will be given the consideration which their merits demand.

Coast Communication With the Great Lakes.

THE Erie Canal was one of the principal agents in establishing the commercial supremacy of New York—both state and city—and during the first half century of its existence it served well the purpose for which it was built. The freight carried on it annually increased from 667,000 tons in 1837 to a maximum of 4,600,000 in 1880, but since then the traffic has fallen to 2,400,000 tons in 1899.

Whatever may be the reasons for this decline, it is certain that the Erie Canal, in its present condition, fails to meet the demands of modern commerce, and if it is not soon radically improved and brought up to date, it will fall into almost complete disuse.

The enormous development of railways in the United States has, of late years, absorbed almost all the attention of those interested in transportation, and when canals have been considered at all, they have been looked upon as relics of a by-gone age. It may be accepted as a fact that the old-

fashioned canals, with a depth of water of only 4 or 6 feet, and carrying boats with a capacity of a couple of hundred tons, have outlived their usefulness, but the country is beginning to realize that these are not the only canals, and that in other parts of the world the development of waterways, fully up to the modern requirements, is being earnestly advocated and has already made considerable progress.

Even in the United States the great traffic on the Sault Ste. Marie canal and other connecting waterways of the Great Lakes has shown the enormous possibilities of through water transit between the Great Lakes and the coast, and lends particular interest to various projects for securing such means of communication.

Last year a New York Canal Commission was appointed by Governor Roosevelt to consider the whole question of the Erie Canal, as well as the more general one of a waterway between Buffalo and the Hudson River; and in its report, issued several months ago, this commission advocates the construction of a barge canal between Buffalo and Albany, following in general the line of the Erie Canal, and having a depth of 12 feet, with a cross-section of 1,200 square feet, which would enable it to carry 1,000-ton barges. The length of this canal would be 341 miles, and its estimated cost about \$59,000,000.

A United States Commission has also issued a report on ship canals 21 feet deep and 30 feet deep, between Buffalo and New York, and a comparison of these various reports gives us some data for determining the relative merits of the different projects. The whole subject is interestingly discussed in two papers in a recent number of the *Proceedings of the American Society of Civil Engineers*, one by Mr. Joseph Mayer and the other by Mr. George Y. Wisner.

The United States Commission proposes the cutting of a canal around Niagara Falls from the upper to the lower reaches of the Niagara River, thus connecting Lake Erie with Lake Ontario. The waterway would leave Lake Ontario again at Oswego and proceed by Oneida Lake and the Mohawk River to the Hudson. An alternative route proposed is from the St. Lawrence River to Lake Champlain, and thence to the Hudson.

The Oswego-Mohawk route has two vari-

ants, a high-level and a low-level plan, which differ chiefly in the amount of lockage required, the other features being very similar. The length of standard canal on all three routes is almost the same, namely, 102 miles, but the total distance from Buffalo to New York by the Champlain route is 685 miles, while by the Oswego-Mohawk it is only 477 miles. The length of canalized river by the Champlain route is 134 miles, by the Oswego-Mohawk, 96 miles, and distances on open lake and river are, respectively, 449 and 279 miles.

The proposed cross-section of the 21-foot waterway is 5,500 square feet.

The estimated costs of the waterways proposed by the United States Commission are as follows:

	30-Ft. Channel.	21-Ft. Channel.
Lake Erie to Lake Ontario	\$73,900,000	\$42,000,000
Lake Ontario to New York—Oswego-Mohawk Route (High Level Plan) . . .	206,000,000	155,000,000
Oswego-Mohawk Route (Low Level Plan) . . .	210,000,000	157,000,000
St. Lawrence-Champlain Route	213,000,000	141,000,000

The total cost of a 21-foot channel from Lake Erie to New York varies from \$183,000,000 to \$199,000,000, as compared with \$59,000,000 for the proposed barge canal of the New York Commission.

The great advantage to be derived from a ship canal is the through carriage of freight from any port on the Great Lakes to New York, the coast harbors of the United States and even to foreign countries. This great controlling advantage would be entirely missed by a barge canal, which would require the transshipment of freight at Buffalo from lake steamer to barge, and again at New York from barge to ocean steamer if the destination lay beyond that city. The barge canal would be merely an enlarged Erie Canal, with many of the latter's inherent disadvantages, and would be, at the best, but a temporary expedient.

Concerning the relative advantage of a 21-foot and a 30-foot channel, it is held that

the size of vessel which can navigate the former answers all the requirements for safe and economic transport on the Great Lakes; and as the bulk of the traffic through the canal would go no further than New York or other places on the Atlantic seaboard, it would hardly pay to excavate a channel deep enough to accommodate the largest class of ocean steamships.

All things considered, the conclusion is reached that the 21-foot waterway is adequate and is best.

The Massena Power Plant.

THE visit of a number of engineers to the works of the St. Lawrence power plant at Massena, gives opportunity to review the progress of that important work, and from an account in a recent issue of the *Engineering Record* some extracts are made.

The hydraulic head is obtained by cutting a canal across from the St. Lawrence to the Grasse river, a stream which runs nearly parallel to the former, and further down discharges into it. The difference in level at the point where the canal is cut gives a power head of about 40 feet, this practically being the fall of the Long Sault Rapids. The tremendous volume of water available renders this an opportunity for the development of a great amount of power, and plans have been made for the early utilization of 90,000 horse power.

The power is to be generated by fifteen sets of turbines, each set consisting of six wheels placed upon a horizontal shaft, at the extremity of which is placed an electric generator. Each set is rated at 6,000 horse power, the generators being of 5,000 horse power capacity. This arrangement differs materially from that at Niagara, the difference being that properly due to the difference in conditions. At Niagara the head is great and the volume available is limited, while at Massena there is only about one-third the head, and much greater volume of water.

The canal by which the water is to be brought from the St. Lawrence is to be 16,200 feet long, and of the total 5,922,000 yards of excavation needed for the first installation of the power station, 4,279,000 yards have been removed. It is now estimated that the plant will be ready for operation by July of 1901, and the turbine plant

for the preliminary installation of 37,500 horse power is now on the ground, ready for installation.

The details of the generators, which have been designed for the plant by the Westinghouse Company, are fully given in the article referred to, and it is expected that a high degree of efficiency will be attained. The control of the output of electricity is especially interesting. One man, by manipulating a series of electric buttons arranged on a small stand, will be able to control instantaneously a power as great as that of three of the largest ocean steamships. Running the length of the power house will be raised a platform, in the middle of which will be built a central controlling stand, made desk fashion, and semi-circular in shape, so that an engineer stationed at its centre will have within reach the controlling apparatus of the entire station.

Mathematics for Engineers.

THE vexed question about the value of a full mathematical training for engineers has been discussed again of late in the columns of *Engineering News*, and some of the points brought out are of importance in connection with engineering education.

As a matter of fact the trouble is not so much with the mathematics as with the manner of teaching. There is no doubt that in many text books the mathematical formulæ and demonstrations are purposely used to display the author's erudition rather than to furnish the pupil with a mastery of one of the most powerful tools ever devised to aid the mind in its conquest of matter. It should be understood that a knowledge of mathematics is a means to an end, a weapon which, to be effectively used, must be fully mastered, and that rote methods and memorized recitations are of about the same value as they would be in teaching the pupil to swim or to ride a bicycle.

The real object of engineering education is to enable the pupil to do things, and in this preparation for his life work he should consider his mathematics as he regards his other professional instruments. Small value will it be to him to be able to rectify well-known curves, by the use of the calculus, for example, if he does not know what he wants the curve for, or cannot apply the knowledge after he has got it.

In many instances the man who is teaching the mathematics is not himself a working engineer, and with all his knowledge of text book methods and reasoning, would be as badly stumped as his pupil if called upon to solve the same problems. It is not unlike the study of a modern language. No matter how well the student may have worked over his grammar and dictionary, he finds his most severe examiner in the first native child with whom he tries to talk, if he has not been given opportunity to absorb by ear the sounds he must understand and make understood.

There is great need for some entirely new mathematical text books, written by engineers for engineering students, and dealing with the actual problems which these same engineers have met and solved. An important qualification for teaching mathematics in a technical school should be a number of years of actual hard practical experience in the application of mathematics to real constructive work. It is not manufactured problems that the professor should set before his pupils; he should not have the convenient privilege of neglecting certain inconvenient elements in the problem in order to make it fit the old-time book methods. Working conditions have an inconvenient habit of appearing in the final result even when they have been neglected in the computation, and in many instances a reputation has been made or marred by the manner in which a problem has been sized up before the computation was begun.

The science of mathematics is all right, and the engineer who really possesses a thorough working knowledge of that science has a great advantage over his less fortunate brother, all other things being equal. The real trouble is that when a man has the knowledge and ability to teach mathematics to engineering students as it ought to be taught, he is able to do so much better for himself outside of the technical school that the professorial chair has no attractions for him.

American Railway Statistics.

THE appearance of Poor's Manual of Railways and the report of the Statistical Bureau of the Interstate Commerce Commission form the occasion of a review of Amer-

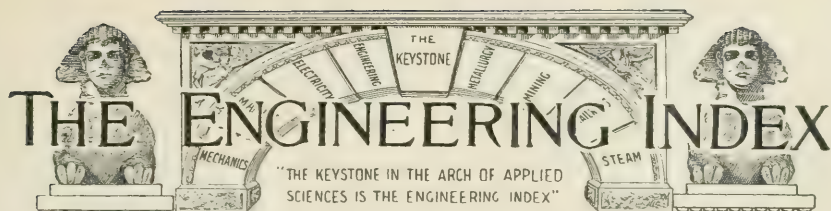
ican railway statistics in a recent issue of *Engineering News*, from which some interesting notes may be made.

Upon the interesting question of total railway mileage, the reports practically agree in making it about 190,000 miles. Great precision cannot be expected in such an indeterminate quantity, since the inclusion or exclusion of electric lines operated by main-line railways, and the question of allowance for yard track and sidings makes an important difference.

There are about 37,000 locomotives in use, and a total of 1,295,000 freight cars, of which 730,000 are fitted with air brakes, and a little more than 1,000,000 with automatic couplers. These are the figures for about a year earlier than the final time, August 1, 1900, allowed by the Interstate Commerce Commission for the enforcement of the law, and as the law does not require all the cars to be equipped with air brakes, but only enough in each train to enable it to be controlled from the engine, there has been ample time to enable the equipment to be completed.

"The movement toward heavier train loads is well shown in the statistics, the average freight-train load in 1899 being 243.52 tons. This is a jump of 17 tons above 1898, and of nearly 40 tons from the figures of 1897, while if we go back to 1890 we find the average freight-train load to have been but 175 tons. Thus the average paying load of the American freight train has increased nearly 40 per cent. in the past decade—a fact worth remembering.

"It is this heavier train loading, more than anything else, which has rendered possible the marvelous drop in rates, which have fallen from an average of 0.941 cents per ton-mile in 1890, to 0.724 cents in 1899. It is worth noting that with the exception of 1892 the drop in rates has been continuous. The average freight train earnings per mile run have remained nearly stationary, but have on the whole slightly increased, the heavier loading a little more than offsetting the lower receipts per ton-mile. Passenger rates have fallen as well as freight rates, though not so rapidly; reaching last year an average per mile of 1.925 cents. Only in 1898 and 1894 has an average rate below 2 cents ever before been reached."



The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language*; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of \$1.00; G, of \$1.20; and H, of \$1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for \$2.00, thirty-three for \$5, and one hundred for \$15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of *THE ENGINEERING MAGAZINE* at 10 cts. per month, or \$1.00 a year; to non-subscribers, 25 cts. per month, or \$3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-g*, semi-quarterly, etc. Other abbreviations used in the index are: *Ill*—Illustrated; *W*—Words; *Anon*—Anonymous.

American Architect. *w*. Boston, U. S. A.
 American Electrician. *m*. New York.
 Am. Engineer and Railroad Journal. *m*. New York.
 American Gas Light Journal. *w*. New York.
 American Geologist. *m*. Minneapolis, U. S. A.
 American Jl. of Science. *m*. New Haven, U. S. A.
 American Machinist. *w*. New York.
 Am. Manufacturer and Iron World. *w*. Pittsburg, U. S. A.
 American Shipbuilder. *w*. New York.
 Annales des Pontes et Chaussées. *m*. Paris.
 Architect. *w*. London.
 Architectural Record. *qr*. New York.
 Architectural Review. *s-g*. Boston, U. S. A.
 Architect's and Builder's Magazine. *m*. New York.
 Australian Mining Standard. *w*. Sydney.

Automobile Magazine. *m*. New York.
 Automotor & Horseless Vehicle Jl. *m*. London.
 Brick Builder. *m*. Boston, U. S. A.
 British Architect. *w*. London.
 Brit. Columbia Mining Rec. *m*. Victoria, B. C.
 Builder. *w*. London.
 Bulletin Am. Iron and Steel Asso. *w*. Philadelphia, U. S. A.
 Bulletin de la Société d'Encouragement. *m*. Paris.
 Bulletin of Dept. of Labor. *b-m*. Washington.
 Bulletin of the Univ. of Wisconsin, Madison, U. S. A.
 Bull. Int. Railway Congress. *m*. Brussels.
 California Architect. *m*. San Francisco, U. S. A.
 Canadian Architect. *m*. Toronto.

- Canadian Electrical News. *m.* Toronto.
 Canadian Engineer. *m.* Montreal.
 Canadian Mining Review. *m.* Ottawa.
 Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
 Colliery Guardian. *w.* London.
 Compressed Air. *m.* New York.
 Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
 Consular Reports. *m.* Washington.
 Contemporary Review. *m.* London.
 Deutsche Bauzeitung. *b-w.* Berlin.
 Domestic Engineering. *m.* Chicago.
 Eclairage Electrique. *w.* Paris.
 Electrical Engineer. *w.* London.
 Electrical Review. *w.* London.
 Electrical Review. *w.* New York.
 Electrical World and Engineer. *w.* New York.
 Electrician. *w.* London.
 Electricien. *w.* Paris.
 Electricity. *w.* London.
 Electricity. *w.* New York.
 Elektrizität. *b-w.* Leipzig.
 Elektrochemische Zeitschrift. *m.* Berlin.
 Elektrotechnische Zeitschrift. *w.* Berlin.
 Elettricita. *w.* Milan.
 Engineer. *w.* London.
 Engineer. *s-m.* Cleveland, U. S. A.
 Engineers' Gazette. *m.* London.
 Engineering. *w.* London.
 Engineering and Mining Journal. *w.* New York.
 Engineering Magazine. *m.* New York & London.
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
 Fire and Water. *w.* New York.
 Foundry. *m.* Detroit.
 Gas Engineers' Mag. *m.* Birmingham.
 Gas World. *w.* London.
 Génie Civil. *w.* Paris.
 Gesundheits-Ingenieur. *s-m.* München.
 Giorn. Dei Lav. Pubbl. e d. Str. Ferr. *w.* Rome.
 Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
 Horseless Age. *m.* New York.
 Ice and Refrigeration. *m.* New York.
 Indian and Eastern Engineer. *m.* Calcutta.
 Iron Age. *w.* New York.
 Iron and Coal Trades Review. *w.* London.
 Iron & Steel Trades Journal. *w.* London.
 Iron Trade Review. *w.* Cleveland.
 Journal Assn. Eng. Societies. *m.* Philadelphia, U. S. A.
 Journal of Electricity. *m.* San Francisco.
 Journal Franklin Institute. *m.* Philadelphia.
 Journal of Gas Lighting. *w.* London.
 Journal Royal Inst. of Brit. Arch. *s-gr.* London.
 Journal of Sanitary Institute. *gr.* London.
 Journal of the Society of Arts. *w.* London.
 Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
 Journal Western Soc. of Eng. *b-m.* Chicago.
 Journal of Worcester Poly. Inst., Worcester, Mass.
 L'Energie Electrique. *w.* Paris.
 Locomotive. *m.* Hartford, U. S. A.
 Locomotive Engineering. *m.* New York.
 Machinery. *m.* London.
 Machinery. *m.* New York.
 Marine Engineering. *m.* New York.
 Marine Review. *w.* Cleveland, U. S. A.
 Metal Worker. *w.* New York.
 Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
 Mines and Minerals. *m.* Scranton, U. S. A.
 Mining and Sci. Press. *w.* San Francisco, U. S. A.
 Mining Reporter. *w.* Denver, U. S. A.
 Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
 Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
 Modern Machinery. *m.* Chicago.
 Moniteur des Architectes. *m.* Paris.
 Moniteur Industriel. *w.* Paris.
 Municipal Engineering. *m.* Indianapolis, U. S. A.
 National Builder. *m.* Chicago.
 Nature. *w.* London.
 Nature. *w.* Paris.
 Nautical Gazette. *w.* New York.
 New Zealand Mines Record. *m.* Wellington.
 Nineteenth Century. *m.* London.
 North American Review. *m.* New York.
 Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
 Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
 Ores and Metals. *w.* Denver, U. S. A.
 Plumber and Decorator. *m.* London.
 Popular Science Monthly. *m.* New York.
 Power. *m.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Soc. Civil Engineers. *m.* New York.
 Proceedings Engineers' Club. *gr.* Philadelphia, U. S. A.
 Proceedings St. Louis R'way Club. *m.* St. Louis, U. S. A.
 Progressive Age. *s-m.* New York.
 Railroad Car Journal. *m.* New York.
 Railroad Gazette. *w.* New York.
 Railway Age. *w.* Chicago.
 Railway & Engineering Review. *w.* Chicago.
 Review of Reviews. *m.* London & New York.
 Revue de Mécanique. *m.* Paris.
 Revue Gen. des Chemins de Fer. *m.* Paris.
 Revue Technique. *b-m.* Paris.
 Revue Universelle des Mines. *m.* Liège.
 Rivista Marittima. *m.* Rome.
 Sanitary Plumber. *s-m.* New York.
 Schweizerische Bauzeitung. *w.* Zürich.
 Scientific American. *w.* New York.
 Scientific Am. Supplement. *w.* New York.
 Stahl und Eisen. *s-m.* Düsseldorf.
 Stevens' Institute Indicator. *gr.* Hoboken, U. S. A.
 Stone. *m.* New York.
 Street Railway Journal. *m.* New York.
 Street Railway Review. *m.* Chicago.
 Telephone Magazine. *m.* Chicago.
 Tramway & Railway World. *m.* London.
 Trans. Am. Ins. Electrical Eng. *m.* New York.
 Trans. Am. Ins. of Mining Eng. New York.
 Trans. Am. Soc. of Civil Eng. *m.* New York.
 Trans. Am. Soc. of Heat & Ven. Eng. New York.
 Trans. Am. Soc. Mech. Engineers. New York.
 Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
 Transport. *w.* London.
 Western Electrician. *w.* Chicago.
 Wiener Bauindustrie Zeitung. *w.* Vienna.
 Yacht. *w.* Paris.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
 Zeitschrift für Elektrochemie. *w.* Halle a. S.
 Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Chimneys.

Chimney Construction. E. J. Philip. Read before the Can. Assn. of Sta. Engrs. Considers the method of designing chimneys for a given purpose. 1100 w. Can Engr—Oct., 1900. No. 37148.

The Design of High Chimneys and Other Similar Structures. Editorial discussion of the stability, rather than the draft, of chimneys. 900 w. Eng Rec—Sept. 29, 1900. No. 36864.

Defects.

Some Defects in Buildings. William O. Ludlow. Discusses some of the defects appearing in buildings and their causes, with suggestions as to what not to do. 1400 w. Stevens Ind—Oct., 1900. No. 37401 D.

Foundations.

Foundations of Buildings. S. Anglin. Read before the Manchester Soc. of Archts. Discusses what constitutes a good foundation and the working loads different foundations are capable of sustaining. 4500 w. Stone—Sept., 1900. No. 36970 C.

Testing Foundations Under Difficult Conditions. Describes methods of making borings in basements with low head room, and in regular use by occupants. 1300 w. Eng Rec—Oct. 20, 1900. No. 37199.

High Buildings.

Height of Buildings. Continuation of an informal discussion on this subject. 7000 w. Pro Am Soc of Civ Engs—Oct., 1900. No. 37259 E.

The Highest Building in the World. Illustration and interesting information in regard to a fine office building about to be erected at the southeast corner of 33d st. and Broadway, New York City. 1000 w. Fire & Water—Oct. 13, 1900. No. 37158.

Hospital.

A Children's Summer Hospital. Illustrated description of the arrangement of the Lewis Memorial Cottage, New Dorp, N. Y., for the treatment of children during the summer months. 800 w. Eng Rec—Oct. 6, 1900. No. 37041.

Library.

The Oakland Public Library. Illustrated description of Carnegie library, with shelf room for 30,000 volumes. 600 w. Eng Rec—Oct. 13, 1900. No. 37146.

Sanitary Building.

House Building from a Surgeon's Standpoint. H. C. Wyman. Describes some things in badly constructed houses that interfere with the health of the inmates. 3700 w. Dom Engng—Oct. 15, 1900. No. 37161 C.

Steel Framing.

The New York Clearing House Dome. Illustrated description of special framing for a heavy hemispherical dome 60½ ft. in diameter. 600 w. Eng Rec—Sept. 29, 1900. No. 36868.

Theatres.

Theatre Construction. Clarence Backhouse. Read before the Insurance Inst., Sydney, Australia. Hints on the planning and construction. 6000 w. Aust Min Stand—Aug. 30, 1900. No. 37073 B.

The Mechanics of Stage Effects (Ueber Bühnentechnik). F. Brandt. A general review of the machinery for producing stage effects, from early times to the present. Two articles, 4000 w. Glaser's Annalen—Oct. 1, 15, 1900. No. 37338 each D.

HEATING AND VENTILATION.

Bank.

Ventilation and Heating of the Detroit State Savings Bank. Illustrated description of special plant for heating by direct radiation and ventilation by the downward system of air distribution. Both the plenum and exhaust systems of ventilation are used. 1600 w. Eng Rec—Sept. 29, 1900. No. 36871.

Building Equipment.

Light, Heat and Power in Buildings. Alton D. Adams. Presents the advantages of a combined plant. 2800 w. Archts' & Builds' Mag—Oct., 1900. Serial. 1st part. No. 36987.

The Mechanical Plant of a Large Apartment House. Illustrated description of the heating, ventilating, lighting, refrigerating and elevator plant in a 13-story, 150 x 75 ft. apartment house in New York. 3500 w. Eng Rec—Oct. 27, 1900. No. 37294.

Fan System.

Heating and Ventilating. Illustrated description of a fan system as applied in the Jackson school, in St. Louis. 1600 w. Dom Engng—Oct. 15, 1900. No. 37165 C.

Greenhouses.

Heating and Ventilation with Regard

to Greenhouses. Robert W. King. Read before the Can. Hort. Assn., at Montreal. Conclusions from experience as to the best means of securing economic and efficient heating. 6300 w. Can Archt—Sept., 1900. No. 36894 C.

Hot Water.

A Large Residence Heating Apparatus. Illustrated description of the plant for heating a 62-room house by hot water; the front portion chiefly by indirect radiation and the back portion by direct radiation. 1300 w. Eng Rec—Oct. 13, 1900. No. 37145.

School Building.

Heating the West Hoboken School Building. Illustrated detailed description. 2000 w. Met Work—Oct. 13, 1900. No. 37078.

Steam Heating.

Tube Diameters in Low Pressure Steam Heating (Die Rohrweiten der Niederdruck Dampfheizung). H. Krug. Showing a method of proportioning the tube diameters with regard to the fall of pressure in a low-pressure system. 6000 w. 1 plate. Gesundheits Ingenieur—Sept. 30, 1900. No. 37334 B.

Waste Heat.

Utilizing Waste Heat from Electric Light Plants for House Heating. Considers in detail the requirements of the system. 5800 w. Dom Engng—Sept. 15, 1900. No. 36891 C.

PLUMBING AND GAS FITTING.

Drain Testing.

Drain Testing by the Application of Water. J. R. Anderson. Discusses arguments for and against this method of testing, but considers it the only reliable test to apply to house drains under ground. 2100 w. Dom Engng—Oct. 15, 1900. No. 37162 C.

Factory Plumbing.

Plumbing in a Detached Manufacturing Plant. Illustrated description of special work in the Weston Electrical Instrument Works, and of a special sewage dis-

posal system. 2100 w. Eng Rec—Oct. 6, 1900. No. 37043.

Progress.

How Plumbers Used to Work in Chicago. David Whiteford. Shows changes in methods caused by improved inventions and a better understanding of sanitary laws. 5600 w. Dom Engng—Oct. 15, 1900. No. 37164 C.

The Progress and Advancement of Plumbing. Reviews some of the improvements in the materials used and manner of executing work. 2300 w. Dom Engng—Oct. 15, 1900. No. 37163 C.

Special Work.

Plumbing in the Cornell Medical College. Illustrates and describes special work for a medical laboratory. 1800 w. Eng Rec—Oct. 20, 1900. No. 37201.

Water Supply.

A Simple Water Supply System in a Tall Building. A description of the water plumbing in a 17-story New York building without roof tanks, the water being pumped into a compression tank in the basement, where 120-lbs. pressure is maintained by compressed air. 700 w. Eng Rec—Oct. 6, 1900. No. 37042.

MISCELLANY.

Acoustics.

Architectural Acoustics; Hall of Representatives, U. S. Capitol, 1853. Letter from W. R. Hutton, describing investigations by Capt. Meigs and Professors Henry and Bache. 900 w. Eng Rec—Oct. 20, 1900. No. 37203.

The Greek Theatres and Their Lesson in Acoustics. John Lyman Faxon. Part first is a résumé of Greek history and the development of civilization which led to the establishment of the theatre; introductory to the subject. 2000 w. Archts' & Builds' Mag—Oct., 1900. Serial. 1st part. No. 36986.

Stained Glass.

Stained Glass at the Paris Exhibition. Critical review of the exhibits of this product. 1600 w. Builder—Sept. 29, 1900. No. 37017 A.

CIVIL ENGINEERING

BRIDGES.

Arches.

Hinged Pointed Arches (Der Spitzbogenenträger mit Scheitelgelenk). Adolf Francke. An elaborate mathematical treatment, with plate showing various examples discussed. 3000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Oct., 1900. No. 37350 D.

Cantilever.

Reinforcing the Niagara Cantilever. Illustrates and describes the method of reinforcing the Michigan Central Railroad's cantilever by means of a new third truss and strengthening the old trusses to have the same deflection as the new one. Part I. describes the old bridge and the method of reconstructing the towers. 2400

w. Eng Rec—Oct. 13, 1900. Serial. Part I. No. 37139.

Strengthening the Cantilever Bridge at Niagara. Brief illustrated description of very difficult work. 1200 w. Sci Am—Oct. 20, 1900. No. 37171.

Concrete-Steel.

The Modified Design for the Memorial Bridge Over the Potomac River at Washington. An illustrated account of the modified design for the concrete-steel arch bridge between Washington and Arlington to commemorate American patriotism. 600 w. Eng Rec—Oct. 13, 1900. No. 37138.

Erection.

Erecting Three Notable Bridges. Brief description of the Clifton, Atbara, and Delaware River bridge-erection methods. 1400 w. Eng Rec—Oct. 27, 1900. No. 37290.

Pneumatic Field Riveting in Railway Bridge Work. Extracts from a report to the Assn. of Ry. Supts. of Bridges and Buildings, giving a statement of advantages of power riveting on three large railway systems. Also editorial discussion. 2500 w. Eng Rec—Oct. 27, 1900. No. 37291.

Temporary Foot Bridge for Placing the Cables of the New East River Bridge. Illustrated description of a temporary suspension bridge for erecting four cables 18¾ inches in diameter and about 3,000 ft. long from anchorage to anchorage. 1600 w. Eng Rec—Oct. 27, 1900. No. 37289.

The Erection of Bridges and Framed Structures (Montages des Ponts et Charpentes). M. Michel-Schmidt. Especially devoted to the methods of erecting recent bridges in France and structures at the Exposition. 4500 w. 5 plates. Mem Soc Ing Civ de France—Sept., 1900. No. 37342 G.

Girder.

A Seventy-one Ton Plate Girder. Illustrated description of a heavy 87-ft. girder and method of its shipment. 900 w. Eng Rec—Oct. 6, 1900. No. 37037.

Reinforcing.

Reinforcing the Newburyport Suspension Bridge. Illustrated description of methods adopted in strengthening for street railway traffic a 244-ft. suspension span built in 1870. 1300 w. Eng Rec—Oct. 6, 1900. No. 37033.

Suspension.

A 1030-Foot Suspension Bridge Span. Illustrated description of a bridge for transporting ore at Miampimi, Mexico. 600 w. Eng Rec—Oct. 20, 1900. No. 37195.

Viaduct.

The Reconstruction of the Kinzua Viaduct. Illustrations and brief account of

the reconstruction made necessary by the recent great increase in the weight of engines and rolling stock. It is said to be the fourth highest bridge in the world. 1200 w. Sci Am—Oct. 27, 1900. No. 37243.

CONSTRUCTION.

Concrete.

Rules for Heavy Concrete Work. A summary of the regulations for the extensive U. S. concrete work at Duluth and on the upper Mississippi. 3300 w. Eng Rec—Sept. 29, 1900. No. 36870.

Concrete Masonry.

Concrete Masonry on the Janesville & Southeastern. Illustrated description of interesting features of this work. 1700 w. Ry & Engng Rev—Oct. 13, 1900. No. 37155.

Excavation.

The Excavation of a Swamp. Describes methods of excavating muck in a reservoir basin. 700 w. Eng Rec—Oct. 20, 1900. No. 37197.

Excavator.

Bucket Excavator (Excavateur en Fouille). Illustrated description of a powerful bucket excavator made by Smulders for constructing irrigation works in Java. 1000 w. Génie Civil—Oct. 6, 1900. No. 37308 D.

Foundations.

See Architectural Engineering.

Framed Structures.

Secondary Stresses in Framed Structures. Thomas A. Clark. Formulas and principles from the writings of H. Mandula, of München. 1600 w. Engs' Year Bk., 1900—Univ of Minn. No. 36966 E.

Girders.

The Strength of I-Beam Girders with Reinforcing Plates. C. F. Blake. Describes a method of calculating the size. 400 w. Am Mach—Oct. 4, 1900. No. 36998.

Reinforced Concrete.

The Use of Expanded Metal in Concrete. A. T. Walmisley. Read before the Brit. Assn., at Bradford. Information concerning the use of this material, particulars of tests, etc. 5200 w. Builder—Sept. 15, 1900. No. 36936 A.

Roads.

Engineering Work in Santiago and Puerto Principe. Illustrated description, mainly of work on mountain highways. 3000 w. Eng Rec—Oct. 6, 1900. No. 37035.

Road Construction and System of Control. A. W. Campbell. Read before the Canadian Soc. of Civ. Engs. Discusses what constitutes a good road, and gives the progress in this direction, as shown in various countries. 5400 w. Adv.

Proof—Can Soc of Civ Engs—Oct. 25, 1900. No. 37281 D.

Road Maintenance in Kent, England. Extracts from a paper by F. W. Ruck, on the methods of maintaining 745 miles of main road in a county where the traffic is very heavy. 2000 w. Eng Rec—Oct. 13, 1900. No. 37142.

Stone Road Building on the Jersey Coast. C. E. McDowell. An illustrated account of good road building. 1600 w. Stone—Sept., 1900. No. 36069 C.

The Maintenance and Construction of Main Roads in England and Wales. Abstract of an article by W. Rees Jeffreys in the *C. T. C. Gazette*. Considers legislative changes needed. 1500 w. Auto Jour—Oct., 1900. No. 37240 A.

Swelling Earth.

Swelling Earth. Letter from Frank Olmsted, describing difficulties experienced from swelling earth during construction of street tunnel in Los Angeles. 700 w. Eng Rec—Oct. 6, 1900. No. 37044.

Tunnels.

Survey and Construction of the Cascade Tunnel by the Great Northern Railway Through the Cascade Range, State of Washington. M. E. Reed. Illustrated account of a tunnel being constructed by the most improved methods. 2500 w. Engs' Year Bk., 1900—Univ of Minn. No. 36964 E.

The Tunnel from the Gardanne Mines to the Sea (La Galerie des Mines de Gardanne à la Mer). A description of the work now in progress to enable the lignite mines of Gardanne to be connected with the Mediterranean, near Marseilles. 3000 w. Revue Technique—Sept. 25, 1900. No. 37313 D.

HYDRAULIC AND MARINE.

Aqueduct.

The Construction of the Elan Aqueduct, Birmingham, England. Abstract of a paper by H. Lapworth, printed by Inst. C. E., describing the work on 12½ miles of aqueduct, involving special methods of trenching, tunneling and pipe-laying. 3900 w. Eng Rec—Sept. 29, 1900. No. 36866.

The Conveying of Water and Power from Ferrari-Galliera to Genoa (Wasserleitungs-und Kraftanlagen Ferrari-Galliera zu Genua). P. Kresnik. An account of the plan to bring the water from lakes Bigio and Lungo to Genoa, with details of dam and aqueduct. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 12, 1900. No. 37321 B.

Canal Locks.

New System of Closing Canal Locks (Nouveau Système de Fermeture des Ecluses). M. Mazoyer. An illustrated

account of the new locks on the canal from Roaune to Digoin, with especial reference to the lock-gates of unusual depth. 2500 w. 1 plate. Annales des Ponts et Chaussées—2 Trimestre, 1900. No. 37-325 E + F.

Canals.

Canals Between the Lakes and New York. Joseph Mayer. Examines arguments for and against the construction of this waterway, showing why private capital cannot safely undertake the construction. 7000 w. Pro Am Soc of Civ Engs—Oct., 1900. No. 37257 E.

The Carillon Canal, Dam and Slide. Ernest Marceau. A short history of earlier work toward improving the navigation of the Ottawa River, with a description of the works named. 4 plates. 7000 w. Can Soc of Civ Engs (Adv. Proof)—Oct. 11, 1900. No. 37133 D.

The Elbe-Trave Canal (Der Elbe-Trave-Canal). J. Riedel. With map and profile, also details of locks. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 28, 1900. No. 37319 B.

The Elbe-Trave Canal (Le Canal de l'Elbe à la Trave). G. Henry. An illustrated description, with especial reference to the Hotopp pneumatic locks. 3000 w. 1 plate. Génie Civil—Oct. 13, 1900. No. 37310 D.

The Economic Dimensions for a Waterway from the Great Lakes to the Atlantic. George Y. Wisner. Discusses the economic depth for canals of large traffic, and gives conclusions drawn. Considers the benefits derived from a 21-ft. waterway nearly as great as could be expected with greater depths. 5400 w. Pro Am Soc of Civ Engs—Oct., 1900. No. 37258 E.

Dredges.

Bucket and Suction Harbour Dredge (Drague Marine à Godets, à Succion et à Refoulement). Illustrated description of powerful new dredge, built by Smulders for the harbour of Port Arthur. 1500 w. Génie Civil—Sept. 15, 1900. No. 37304 D.

Mammoth Dredging Steamer Launched. Describes the launching from the shipyard of the Maryland Steel Co., of the "Thomas," the first of two built to deepen New York harbor. 2700 w. Naut Gaz—Oct. 4, 1900. No. 37002.

The Sea-Going Hydraulic Dredge "Benyard." Description of dredge for Southwest Pass of Mississippi River; the dredging machinery has an hourly capacity of 2,000 yards of sand from a depth of 30 ft. 1000 w. Eng Rec—Oct. 6, 1900. No. 37036.

Dry Dock.

Reconstruction in Concrete of Dry Dock No. 2, New York Navy Yard. Brief illustrated account of these repairs.

1500 w. Sci Am—Oct. 20, 1900. No. 37170.

Filtration.

Economical Dimensions of Rectangular Filter Beds. John H. Gregory. Formulas and diagrams of value in making arrangements of filters. 500 w. Eng News—Oct. 11, 1900. No. 37107.

Filtration of Water for Public Use. Continued informal discussion. 3000 w. Pro Am Soc of Civ Eng—Oct., 1900. No. 37260 E.

Surface Water Filters, Marlborough, Mass. Describes filters for the run-off of a well-populated area of 1.8 sq. miles, draining into a large reservoir. Also editorial on the purification of storm water. 1500 w. Eng Rec—Oct. 6, 1900. No. 37040.

Ground Water.

Movements of Ground Water. Benjamin Smith Lyman. Reviews the reports of F. H. King and C. S. Slichter, as given in Part II. of the nineteenth annual report of the U. S. Geol. Survey. 6000 w. Jour Fr Inst—Oct., 1900. No. 36994 D.

Irrigation.

Irrigation in India. F. C. Cotton. The object of the paper is to show how the nation may be rescued from famines and enriched by the water of its great rivers, and the prosperity that will follow. 6300 w. Jour Soc of Arts—Oct. 12, 1900. No. 37204 A.

Lighthouses.

The Lighthouse and Signal Devices of Sautter, Harlé & Co. (Phares et Signaux Sonores Sautter, Harlé et Cie). With illustrations of the workshops and detailed descriptions of the lights and sound signals constructed by this famous French establishment. 2500 w. Revue Technique—Sept. 25, 1900. No. 37312 D.

Lighthouse at Jennings Point. Drawing and brief description of a steel-frame lighthouse. 500 w. Engr, Lond—Sept. 21, 1900. No. 36957 A.

Measurement.

Water Measurement in Colorado. Illustrated explanation of methods used in irrigation districts. 1000 w. Fire & Water—Sept. 29, 1900. No. 36910.

Mississippi.

The Projected Improvement of the Southwest Pass. William Starling. Describes the present condition of the pass and gives a full detailed discussion of the project. 14500 w. Eng News—Oct. 4, 1900. No. 37003.

Nicaragua Canal.

Test Borings for the Isthmian Canal Commission. Describes methods of sinking bore-holes through rock and earth on the projected line of the Nicaragua Canal.

1700 w. Eng Rec—Sept. 29, 1900. No. 36867.

Reservoirs.

A Small Concrete and Expanded Metal Reservoir. Illustrated description of a covered circular tank built without centers and provided with expanded metal reinforcement of top, bottom and sides. 1100 w. Eng Rec—Oct. 20, 1900. No. 37196.

Asphalt and Brick Reservoir Linings. Illustrated description of method of lining reservoirs with concrete base, asphalt and burlap water-proofing courses and brick paving. 600 w. Eng Rec—Oct. 6, 1900. No. 37034.

Masonry for Water-Works Plants. Charles A. Hague. On the care needed in building a watertight wall, and the faulty methods used. 2200 w. Fire & Water—Sept. 29, 1900. No. 36909.

Water Analysis.

Standard Methods of Water and Sewage Analysis. A criticism of the divergent methods of analysis and in stating results, which diminish the value of such work to engineers. 1300 w. Eng Rec—Oct. 13, 1900. No. 37135.

Standard Methods of Water Analysis. The recommendations of a special committee of analysts appointed by the American Public Health Assn. 5800 w. Eng Rec—Oct. 27, 1900. No. 37293.

Water Pollution.

Frequent Biological Examination of the Water Supply a Necessity. Showing that the presence of the colon bacillus is frequently discovered and is a sure indication of sewage pollution. 1800 w. Fire & Water—Sept. 22, 1900. No. 36885.

Water Purification.

Rendering the Water of the Seine Wholesome. From *La Nature*. Historical review with illustrated description. 3000 w. Sci Am Sup—Oct. 13, 1900. No. 37072.

Water Rights.

Interstate Rights to Water. A decision by a U. S. District Court, awarding damages to riparian owners of Connecticut against New York City for the diversion of water. 1000 w. Eng Rec—Oct. 13, 1900. No. 37137.

Water Supplies.

Improvement of Water Supplies. G. Bouscaren. Read at Milwaukee meeting of the Am. Soc. of Munic. Imp. On the essential requisites in water for domestic use, and the systems of purification applied. 1400 w. Munic Engng—Oct., 1900. No. 36973 C.

The Newburyport Water-Works Litigation. Review of a decision by a U. S. district court, holding that in the case of a non-exclusive franchise for public

service, a legislative act indirectly forcing an existing company to sell its plant to a city is not a taking without due compensation, against the constitution of the United States. 2300 w. Eng Rec—Oct. 20, 1900. No. 37194.

The Water Supply for the Suburbs of Paris (Die Wasserleitung für die Umgebung von Paris). Thomas Hofer. With plan of the environs of Paris, and details of apparatus for water purification by metallic iron. 4000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Oct., 1900. No. 37349 B.

Water Works.

Newark Owns Its Water Works. Illustrated description of a nine and a half million dollar plant. 110 w. Fire & Water—Oct. 20, 1900. No. 37229.

The Chestnut Hill Pumping Stations of the Metropolitan Water-Works, Boston. Alfred D. Flinn. The first article illustrates and describes a high-service station and gives a report of a pumping engine test, in which a duty of 157,000,000 ft.-lbs. per million B. T. U. was furnished. 4000 w. Eng Rec—Oct. 18, 1900. Serial. 1st part. No. 37141.

The New England Water-Works Association. Report of convention, giving abstracts of papers by L. P. Kinnicutt on bacterial sewage treatment in England to prevent pollution of rivers, and of M. Knowles on the efficiency of sand and mechanical filters at Pittsburg, with comparative tables. 4000 w. Eng Rec—Sept. 29, 1900. No. 36872.

The New Pumping Station and Water Tower in Vienna. Illustrated description from the *Zeitschrift d. Oest. Ing. u. Arch. Ver.* of an elaborate water tower with both Intze and annular tanks, and small pumping engines with mechanically controlled suction valves; the result of tests of the engines is also given. 1500 w. Eng Rec—Oct. 6, 1900. No. 37038.

The Orange Water-Works Extension. Illustrated description of a new plant using an old abandoned reservoir at higher elevation to furnish water for driving pumps for new supply. 2300 w. Eng Rec—Oct. 27, 1900. No. 37292.

MATERIALS.

Cement Tests.

Accelerated Tests for Cement. A letter on the manner of conducting the Michaelis test, with editorial on the reliability of accelerated tests in general. 1400 w. Eng Rec—Oct. 13, 1900. No. 37136.

Cement.

Weights of Portland Cement and Capacity of Cement Barrels. Sanford E. Thompson. Information compiled from tests made by the Boston Transit Com-

mission. 500 w. Eng News—Oct. 4, 1900. No. 37004.

Concrete.

A Symposium on Concrete and Its Uses. Abstract of information compiled by W. A. Rogers from reports of representatives of over 85,000 miles of railways. 2500 w. Eng Rec—Oct. 20, 1900. No. 37200.

Models.

Models and Model Loading (Modell und Modellbelastung). G. Griot. A discussion of the relative strength of models and full size structures, with an example of a loaded model roof truss. 1200 w. Schweizerische Bauzeitung—Oct. 13, 1900. No. 37333 B.

Timber Reservation.

A Proposed Method for the Preservation of Timber. Continued discussion of paper by F. A. Kummer. 2500 w. Pro Am Soc of Civ Engs—Oct., 1900. No. 37262 E.

MUNICIPAL.

Garbage.

Garbage Cremation at Bradford, England. Describes methods of disposing of most of the ashes and garbage from a population of 300,000, with results of a 278-hour test of plant. 500 w. Eng Rec—Sept. 29, 1900. No. 36869.

Garbage Disposal Works, Syracuse, N. Y. Illustrated description of works on the improved Holthaus system. 1100 w. Eng News—Oct. 11, 1900. No. 37105.

Pavements.

Bacterial Studies of the Healthfulness of Street Pavements of Lafayette, Ind. Daniel B. Luten and Severance Burrage. An illustrated account of investigations to determine the relative number of bacteria liable to be inhaled by breathing the air over the various pavements. 2500 w. Eng News—Oct. 11, 1900. No. 37104.

Refuse.

The Disposal of House Refuse in Bradford. John McTaggart. Read before the British Assn. Describes the refuse destructors, and methods of utilizing the residuum, giving results of working tests. 4200 w. Engng—Sept. 21, 1900. No. 36949 A.

The Disposal of Towns' Refuse. Ed. C. de Segundo. Reviews Mr. McTaggart's paper, read before the British Assn. 1200 w. Elec Rev, Lond—Sept. 21, 1900. No. 36943 A.

Sewage Purification.

Recent Progress in Sewage Purification in England. Abstract of paper read by Gilbert J. Fowler before the Am. Soc. of Munic. Imp. Gives outline of experiments on biological methods of sewage

treatment and conclusions. 900 w. Munic Engng—Oct., 1900. No. 36974 C.

The Unsuccessful Sewage Purification Plant at Madison, Wis. Extracts from the report of F. E. Turneure, with explanatory notes. 3300 w. Eng News—Oct. 11, 1900. No. 37108.

Sewerage.

Manhole for Gauging. Illustrated description of a special manhole with triangular weir for catching sewage at Liberty, N. Y. 400 w. Eng Rec—Oct. 20, 1900. No. 37202.

Sanitary Conditions in Hong Kong. Abstract of paper by Robert G. Alford, before the Inst. of Civ. Engs., describing the difficulties of sewerage in a community made up mainly of Chinese. 2500 w. Eng Rec—Oct. 20, 1900. No. 37198.

Sydney and Suburbs Low Level Sewerage. A. E. Cutler. Read before the Engng. Assn. of N. S. W. Describes the

work as carried out, and the operation of the mechanism employed. 2500 w. Aust Min Stand—Sept. 20, 1900. Serial. 1st part. No. 37253 B.

The Concord Sewage Pumping and Electric Station. Illustrated description of the construction of the foundations of a sewage well and pumping station under extremely difficult conditions, with notes on the power plant. 3900 w. Eng Rec—Oct. 6, 1900. No. 37039.

The Sewerage Works at Flemington, N. J. Illustrated description of the construction and cost of sewers for a village of 2,200 people, with broad irrigation fields for disposal. 2000 w. Eng Rec—Sept. 29, 1900. No. 36865.

The New Sewer Outfall at Burlington, Ia. Illustrates and describes a structure designed to take the place of an outlet three times destroyed by storms. 1000 w. Munic Engng—Oct., 1900. No. 36975 C.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

An Explanation of a Common Phenomenon Noticed in Cable Work. H. G. Barwell. An explanation of the sharp kicks noticed on the galvanometer while a splice is being made. Ill. 1300 w. Elect'n, Lond—Sept. 21, 1900. No. 36940 A.

Some Interesting Faults Met with in Cable Manufacture. J. Wright. Showing the difficulties with which the manufacturer must contend. 2500 w. Elec Rev, Lond—Oct. 12, 1900. No. 37209 A.

Contacts.

Electrical Contracts. Frank C. Mason. Read at the Pittsburg meeting of the International Assn. of Munic. Elect'ns. Discusses the three classes of contacts, and the things that destroy their efficiency. 1600 w. W Elect'n—Oct. 6, 1900. No. 37059.

Impedance.

A Practical Method of Impedance Testing for Telephone Men. Sewall Cabot. Describes a method of calculating the resistance to alternating currents of circuits containing impedance. 400 w. Elec Wild & Engr—Oct. 20, 1900. No. 37214.

Printing Telegraph.

Improvement in the Efficiency of the Hughes Instrument (Erhöhung der Leistungsfähigkeit des Hughes-Apparates). G. Conradt. Discussing an improved arrangement of keyboard, claimed to possess material advantages. 4000 w. Elektrotech Zeitschr—Sept. 13, 1900. No. 37352 B.

Rapid Telegraphy.

The Pollak and Virag Rapid Telegraph (Der Schnell telegraph von Pollak und Virag). An illustrated description of the latest improvements in the system. A legible script message is transmitted, instead of equivalents of the Morse characters. 2500 w. Elektrotech Zeitschr—Oct. 11, 1900. No. 37360 B.

Telegraphone.

The Poulsen Telegraphone (Le Télégraphone Poulsen). G. Briad. A description of this combination of telephone and phonograph, successfully used for recording telephone messages. 1000 w. Génie Civil—Sept. 29, 1900. No. 37306 D.

Vienna.

The Vienna Telephone Stations (Die Wiener Fernsprechämter). H. Dreisbach. Describing especially the underground conductors, and methods of making connections. Serial, Part I. 4500 w. Elektrotech Zeitschr—Oct. 18, 1900. No. 37364 B.

DISTRIBUTION.

Alternating Currents.

Distribution of Power by Alternate Electric Currents. Concerning alternate-current transformers, explaining the principles and operation. Ill. 4700 w. Col Guard—Sept. 21, 1900. Serial. 1st part. No. 36951 A.

Cables.

The Warming of Electric Conducting Cables (Ueber die Erwärmung Elektrischer Leitungskabel). J. Herzog and C. Feldman. With data of observations

upon a number of cables, and methods of computing safe temperature limits. 7500 w. *Elektrotech Zeitschr*—Sept. 20, 1900. No. 37353 B.

Condensers.

The Use of Condensers. P. Boucherot. Abstract of a paper before the International Elec. Cong., at Paris. Examines the most important applications, and the reasons against their use. 3000 w. *Elect'n, Lond*—Oct. 12, 1900. No. 37-228 A.

Distribution Systems.

Notes on Systems of Distribution. Ellis H. Crapper. The systems are discussed and the factors to be considered in deciding which to adopt. 1000 w. *Elec, Lond*—Oct. 19, 1900. Serial. 1st part. No. 37279 A.

Systems and Apparatus for Light and Power Distribution. C. P. Steinmetz. Read at convention of the Assn. of Edison Illuminating Companies. Discusses the nature and behavior of the apparatus used. 2800 w. *Elec Wld & Engr*—Sept. 29, 1900. Serial. 1st part. No. 36903.

Guard Wires.

Overhead Construction, with Special Reference to Guard Wires. Sydney Woodfield. Discusses the cause of accidents, present practice, and suggests points with regard to their erection. Ill. 2800 w. *Elec Rev, Lond*—Sept. 21, 1900. No. 36941 A.

Rotary Converters

See Mining and Metallurgy, Mining.

Shielding.

The Shielding Action of Iron Tubes (Ueber die Schirmwirkung von Eisenröhren). C. Feldmann and J. Herzog. A comparison between calculations and observations for tubes of various diameters and thicknesses. 1800 w. *Elektrotech Zeitschr*—Oct. 18, 1900. No. 37-362 B.

Wiring.

Interior Wiring. G. C. Allingham. Discusses the systems used and the safety. 2400 w. *Elec Rev, Lond*—Sept. 28, 1900. No. 37013 A.

ELECTRO-CHEMISTRY.

Electrolytic Baths.

New Process for the Production of Electrolytic Baths. On advantages of an admixture of glycerine. 1100 w. *Sci Am Sup*—Oct. 27, 1900. No. 37248.

Ions.

Ions, Atoms and Electrons. Reviews the discussion on "Ions" which took place at the Bradford meeting of the British Assn. 2200 w. *Elec Rev, Lond*—Oct. 5, 1900. No. 37122 A.

Nomenclature.

Electrochemical Nomenclature (Elek-

trochemische Bezeichnungen). M. A. Hollard. Giving the electrochemical terms adopted by the recent Congress in Paris. 1000 w. *Zeitschr f Elektrochemie*—Sept. 20, 1900. No. 37369 G.

Primary Cells.

The Osmotic Pressure Theory of Primary Cells. W. R. Cooper. From a book on "Primary Batteries," soon to be published. Explains the nature of osmotic pressure, and of electrolytic solution pressure and manner of calculating the E. M. F. 2300 w. *Elect'n, Lond*—Sept. 28, 1900. Serial. 1st part. No. 37127 A.

ELECTRO-PHYSICS.

Core Tests.

Transformer Core Ageing Tests. W. Elwell Goldsborough. A report of experimental investigations. 1800 w. *Elec Rev, N. Y.*—Oct. 17, 1900. No. 37182.

Electric Waves.

Molecular Changes Produced in Matter by Electric Waves. Reviews the paper by Dr. Jagadis Chunder Bose, read before the Royal Society, with comments. 1500 w. *Elec Rev, Lond*—Sept. 21, 1900. No. 36942 A.

Insulation.

The Ethics of Insulating Materials. J. Wright. Considers the substances, chiefly india-rubber and gutta-percha, used for the insulation of electric cables and wires. 2000 w. *Elec Rev, Lond*—Sept. 21, 1900. No. 36944 A.

Interrupters.

Method of Determining the Number of Interruptions in Liquid Interrupters (Methoden zur Bestimmung der Unterbrechungszahlen von Flüssigkeitsunterbrechern). Ernst Ruhmer. The interruptions are recorded upon a revolving disk covered with lycopodium. 2000 w. *Elektrotech Zeitschr*—Oct. 4, 1900. No. 37357 B.

Magnetism.

The Magnetic Properties of Iron Filings as Affected by Ferro-Manganese. Ernest Wilson. Describes methods of experimenting and results obtained. 1100 w. *Elect'n, Lond*—Oct. 5, 1900. No. 37-130 A.

Resistance.

Experiments on High Electrical Resistance. Ogden N. Rood. Explanation of methods and account of experiments. 4200 w. *Am Jour of Sci*—Oct., 1900. No. 36961 D.

See Street and Electric Tramways.

The So-called "Skin Effect" or the Increased Resistance of Iron Wires to Alternating Currents. B. Hopps. Results of tests and curves. 400 w. *Elect'n, Lond*—Oct. 12, 1900. No. 37224 A.

Temperature.

Stability of Temperature in an Electric Conductor. H. E. Wimperis. An account of investigations made by the writer. 1100 w. *Elect'n, Lond*—Oct. 12, 1900. No. 37226 A.

GENERATING STATIONS.**Accumulator.**

The Cadmium Accumulator (*Accumulateur au Cadmium*). A description of the Commelin and Viau system, with a positive plate of peroxide of lead and a negative of deposited cadmium. Diagrams of the performance are given. 1200 w. *L'Electricien*—Oct. 13, 1900. No. 37367 B.

Air Gap.

The Apparent Increase in the Air-Gap of Dynamos and Motors Due to Toothed Armatures. C. F. Guilbert. Translated from *L'Industrie Electrique*. Describes method of calculating the apparent increase. 700 w. *Elec Rev, N. Y.*—Oct. 10, 1900. No. 37150.

Alternators.

Alternating Current Plants (*Ueber Wechselstromanlagen*). H. S. Myer. A general discussion of the points to be considered in installing an alternating-current plant. 5000 w. *Elektrotech Zeitschr*—Oct. 18, 1900. No. 37361 B.

Conditions Affecting the Wave Form of Alternators. L. A. Herdt and E. M. Archibald. Paper read before the Can. Elec. Assn. Considers the extent to which the E. M. F. wave of certain machines may change under not unusual commercial conditions. Ill. 800 w. *Can Engr*—Sept., 1900. No. 36887.

Extending Applications of Alternating Machines. Alton D. Adams. On the rapid rate at which this machinery has grown in favor for both light and power, and its advantages. 2500 w. *Sci Am*—Oct. 27, 1900. No. 37245.

Buenos Aires.

The Plant of the General Electric Company of Buenos Aires (*Das Elektrizitäts werk der Compania General de Electricidad de Buenos Aires*). W. Hulke. A very full description, with many illustrations showing the course of erection of the machinery. 4000 w. *Elektrotech Zeitschr*—Oct. 11, 1900. No. 37358 B.

Dynamos.

A Continuous-Current Dynamo for Widely Varying Voltages, Designed by E. Lanhoffer. Condensed translation from *L'Electricien*. Illustrates and describes the machine and its action, making claims that the editor considers too wide to be substantiated. 3500 w. *Elec Engr, Lond*—Oct. 12, 1900. No. 37206 A.

Continuous Current Dynamo with Dif-

ferential Pressures (*Dynamo à Courant Continu à Tension Différentielle*). A description of the Lanhoffer system, by which a variation in the pressure of the current is obtainable. 3000 w. *L'Electricien*—Sept. 29, 1900. No. 37366 B.

On the Construction of Dynamo-Electric Machines. Maurice Leblanc. Read before the International Cong., at Paris. Description, with illustrations of construction on lines approved by the writer. 4200 w. *Elect'n, Lond*—Oct. 12, 1900. No. 37227 A.

The Dynamos of the International Electrical Company (*Les Dynamos de la Compagnie Internationale d'Electricité*). Paul Saney. Especially describing the 1,000 kilowatt three-phase generator shown at Paris, coupled to a compound steam engine by Van den Kerchove. 1200 w. *Revue Technique*—Oct. 10, 1900. No. 37315 D.

The Philosophy of Dynamo Design. Considers various points that must be kept in mind by the successful designer of continuous-current machines. 2200 w. *Elec Engr, Lond*—Oct. 17, 1900. Serial. 1st part. No. 37284 A.

The Tendency of Modern Dynamo Design. William Cramp. Conclusions reached by a study of the exhibits at the Paris Exhibition. Ill. 2000 w. *Elec Engr, Lond*—Oct. 5, 1900. No. 37124 A.

Generating Set.

Belleville-Breguet Compound Generating Set (*Groupe Electrogène Belleville-Breguet*). A description of the exhibit at the Paris Exposition, and an analysis of the action of the compound alternator. 3500 w. *L'Electricien*—Oct. 20, 1900. No. 37368 B.

Generating Set of 1,000 Kilowatts (*Groupe Electrogène de 1,000 Kilowatts*). Ch. Dantin. Illustrated description of the set consisting of a 1,250 h. p. Delaunay Belleville engine connected to a 1,000 kilowatt three-phase generator, by Breguet, exhibited at Paris. 3000 w. 1 plate. *Génie Civil*—Sept. 8, 1900. No. 37300 B.

Generators.

The Designing of Large Tramway Generators. Horace F. Parshall. Discusses the subject in relation to efficiency. The losses, dimensions, etc., are also considered. 3500 w. *St Ry Jour*—Oct. 13, 1900. No. 37081 D.

Geneva.

The Electricity Works of Chèvres (Geneva). An illustrated account of some of the difficulties overcome and successes achieved in this hydraulic undertaking. 2200 w. *Elec Rev, Lond*—Oct. 12, 1900. Serial. 1st part. No. 37208 A.

Power Factor.

Power Factor as Affecting Operation and Investment, with Special Reference

to Induction Motors and Enclosed Arc Lamps. F. H. Leonard, Jr. Read before the Can. Elec. Assn. Deals with subjects of importance to central station managers. Also discussion. 5700 w. Can Engr—Sept., 1900. No. 36888.

Power Plants.

Barnsley Electricity Supply Works. Historical and descriptive account, with illustrations. 4800 w. Elec Engr, Lond—Sept. 21, 1900. No. 36938 A.

The New Municipal Power Stations in Liverpool. Illustrated description of a plant to meet the rapidly increasing demand for electrical energy for lighting and for tramways. 1900 w. Elect'n, Lond—Oct. 19, 1900. No. 37285 A.

The Electric and Hydraulic Power Plant of the Saint Lawrence Power Company, Massena, N. Y. Charles T. Child. Illustrates and describes the engineering and construction features of this enormous development of hydraulic power for electric transmission and utilization. 2200 w. Elec Rev, N. Y.—Oct. 24, 1900. No. 37298.

Power Station.

See Street and Electric Tramways.

Station Test.

Test of the Lighting and Power Station of Cornell University. M. W. Buchanan and F. J. Folk. Abstract of thesis presented for degree of M. E. Describes the turbines, engines, boilers, and dynamos, and the tests made, with remarks on the plant. 2000 w. Sib Jour of Engng—Oct., 1900. No. 37178 C.

Storage Batteries.

See Street and Electric Tramways.

Transformers.

A New Constant-Potential Continuous Current Transformer. F. W. Davis. Brief illustrated description of a simple method of compensating for the voltage drop in the secondary at full load. 1000 w. Elec Rev, Lond—Oct. 19, 1900. No. 37286 A.

The Latest Development in Transformer Design and Operation. H. C. Wirt. The reasons why old forms have been discarded; the requirements; and illustrated descriptions. Also discussion. 2800 w. Jour of Elec—Aug., 1900. No. 36893.

Wind Power.

Wind Power for Electrical Purposes. Roy E. Thompson. Explains the methods by which wind power may be applied and how they are governed. 1400 w. Engs' Year Bk., 1900—Univ of Minn. No. 36965 E.

HEATING AND WELDING.

Water Heater.

The Ougrimoff Electric Heater

(Calorifacteur Electrique, Systeme Ougrimoff). J. A. Montpellier. The water is heated by an electric arc enclosed in the center of the containing vessel. 1200 w. L'Electricien—Sept. 22, 1900. No. 37365 B.

LIGHTING.

Accounting.

A Model System of Book-Keeping for Electric Lighting Companies. John Lyle Clough. Outlines the system used by the Edison Light Co., of Grand Rapids, Mich. 1300 w. Munic Engng—Oct., 1900. No. 36971 C.

Arc Lighting.

Arc Lighting in Power Transmission Service. H. W. Hillman. Discusses the enclosed arc system; the troubles of the past and the remedies; the advantages, etc. Ill. Also discussion. 6500 w. Jour of Elec—Aug., 1900. No. 36892.

Glasgow.

The Electric Lighting of the City of Glasgow. Begins an illustrated description of the Glasgow electricity works at Port Dundas. 2400 w. Elec Engr, Lond—Sept. 21, 1900. Serial. 1st part. No. 36939 A.

Illumination.

The Light Emitted by the Continuous-Current Arc. Mrs. Ayrton. Abstract of a paper read before the International Congress, at Paris. A record of scientific investigation, with editorial comment. 5500 w. Elect'n, Lond—Oct. 12, 1900. Serial. 1st part. No. 37225 A.

Lamp Rating.

Mistakes in the Rating of Incandescent Lamps. Arthur J. Rowland. A discussion of some things regarding the real candle-power and watts per candle power, etc. 2000 w. Jour Fr Inst—Oct., 1900. No. 36992 D.

Lamps.

Development of Electric Lamps. André Blondel. Abstract of a paper read before the Inter. Elec. Cong., at Paris. Reviews the progress and the improvements desirable in arc and incandescent lamps. 3300 w. W Elect'n—Sept. 29, 1900. No. 36921.

Photometry.

Photometry. J. Violle. Abstract of a report to the International Elec. Cong., at Paris. 4800 w. Elect'n, Lond—Sept. 28, 1900. No. 37128 A.

Street Lighting.

A Modern Street Lighting Plant. George A. Damon. Illustrated description of the municipal arc-light plant at Grand Rapids, Mich. 2400 w. Am Elect'n—Oct., 1900. No. 37061.

Statistics on Electric Street Lighting. Report of F. W. Coppelen, based on sta-

tistics published by the U. S. Dept. of Labor. 1000 w. Munic Engng—Oct., 1900. No. 36972 C.

MEASUREMENT.

Alternating Currents.

The Accurate Measurement of Alternating and Multiphase Currents. G. L. Addenbrooke. Abstract of paper read at the International Congress, at Paris. Gives results of experience, describing the method and the design of the apparatus and instruments, and the manner of using them. 3700 w. Elect'n, Lond—Oct. 5, 1900. No. 37131 A.

Cable Resistance.

Measurement of the Resistance of Cables. Arthur C. Heap. Describes the potentiometer, and the method of measuring for the use of manufacturers. Ill. 2000 w. Elec Rev, Lond—Oct. 5, 1900. No. 37121 A.

Drop.

Ohm's Law Applied to the Calculation of Drop in Constant Current Circuits. Albert F. Ganz. Considers a number of numerical problems illustrating the calculation of drop in various forms of lighting circuits. 1800 w. Stevens Ind—Oct., 1900. No. 37402 D.

Electrodynamometer.

Mirror Electrodynamometer for Technical Uses (Elektrodynamometer mit Spiegelablesung für Technische Zwecke). J. Kollert. Fully illustrated description of the dynamometer, with mathematical demonstration of its action. 6000 w. Elektrotech Zeitschr—Sept. 20, 1900. No. 37354 B.

Motor Slip.

A Method for Measuring the Slip of Induction Motors. W. Hand Browne, Jr. Describes a method in which the slip is measured directly, and which has been found entirely satisfactory during a year's use. 1300 w. Elec Wld & Engr—Oct. 13, 1900. No. 37103.

Power Indicator.

Power Factor Indicator. Aug. J. Bowie, Jr. Describes an instrument that will indicate the power factor directly on a scale suitably calibrated. 1500 w. Elec Wld & Engr—Oct. 27, 1900. No. 37268.

Recording Instruments.

Switchboard Improvements. Recording Ammeters, Voltmeters, and Wattmeters. William Baxter, Jr. Illustrates and describes several instruments. 1700 w. Am Mach—Oct. 4, 1900. No. 36997.

Resistance Bridge.

A Universal Carey-Foster Bridge. Charles V. Drysdale. An illustrated description of the writer's method of using the Carey-Foster bridge in resistance

work. 1800 w. Elect'n, Lond—Oct. 5, 1900. No. 37129 A.

Resistances.

Otto Wolf's Standard Resistances in Electrical Measurement. Wallace M. Hill. Description of methods, with illustrations. 3500 w. Stevens Ind—Oct., 1900. No. 37403 D.

Testing.

Dynamo and Motor Testing. John H. Hertner. Points out a number of shop and laboratory tests, showing how they are applied, and gives a few practical methods of discovering and curing dynamo and motor diseases. Ill. 2500 w. Engr, U. S. A.—Oct. 1, 1900. No. 36927.

POWER APPLICATIONS.

Agriculture.

The Application of Electricity to Agriculture. George E. Walsh. Some methods used to stimulate crops and to lessen the cultivation and transportation labor. 1500 w. Elec Rev, N. Y.—Oct. 10, 1900. No. 37151.

Brakes.

Electric Brakes for Alternating Currents (Elektrische Bremsen für Wechselströme). J. Fischer-Hinnen. With especial reference to electrically released mechanical brakes for hoisting machinery. Methods of designing brakes for one, two, and three-phase currents are given. 3500 w. Elektrotech Zeitschr—Sept. 13, 1900. No. 37351 B.

Cranes.

See Mechanical Engineering, Machine Works and Foundries.

Current Consumption.

See Street and Electric Tramways.

Cutting Iron.

Cutting Structural Iron by Means of the Electric Arc. J. R. Cravath. Brief account of manner of doing the work. 600 w. Am Elect'n—Oct., 1900. No. 37063.

Electric Motor.

See Street and Electric Tramways.

Machine Driving.

Motor-driven Lathes. Illustrates and describes different methods in use. 800 w. Elec Rev, Lond—Sept. 28, 1900. No. 37012 A.

Mining Plant.

The Electric Power Plant of the Redjang Lebong Gold Mine, Sumatra (Die Elektrische Kraftübertragungsanlage der Goldgrube Redjang-Lebong, Sumatra). W. Philippi. Showing the difficulties in conveying and erecting the plant and its successful installation. 2500 w. Glückauf—Oct. 6, 1900. No. 37347 B.

Motors.

The Experimental Determination of the

Time Relation between Current and Pressure in Rotors of Asynchronous Motors. (Ueber die Experimentelle Bestimmung des Zeitlichen Verlaufes von Strom und Spannung im Rotor von Asynchronmotoren). H. Rupp. Giving a detailed description of apparatus and experiments. 3000 w. *Elektrotech Zeitschr*—Oct. 4, 1900. No. 37355 B.

TRANSMISSION.

Copper Saving.

Copper Saving in the Joint Transmission of Direct and Alternating Currents. Fredrick Bedell. Full paper read at the N. Y. meeting of the Am. Assn. for the Adv. of Science. Calculation of the saving that may be made in the weight of copper and in copper cores. 2100 w. *Sib Jour of Engng*—Oct., 1900. No. 37177 C.

High Tension.

Two European Direct-Current, High-Tension Transmissions. Frank C. Perkins. Brief illustrated description of the Isoverda-Genoa transmission, and that installed at Chaux-de-Fonds and Locle. 700 w. *Jour of Elec*—Sept., 1900. No. 37176.

Mine Transmission.

Mr. Heather's Paper on the Electric Transmission Plants at Moodie's Gold Mines. E. K. Scott. A review of paper concerning mines in South Africa. 1100 w. *Elec Rev, Lond*—Oct. 5, 1900. No. 37120 A.

Wave Form.

Effect of Wave Form on Capacity Current of Transmission Lines. F. G. Baum. Analytic study. 1000 w. *Elec Wld & Engr*—Oct. 20, 1900. No. 37215.

MISCELLANY.

Gravitation.

An Explanation of Gravitation. Reginald A. Fessenden. Considers it a secondary electric effect. 2000 w. *Elec Wld & Engr*—Sept. 29, 1900. No. 36902.

Nomenclature.

Nomenclature of Electrical Apparatus. Charles P. Steinmetz. Discusses needed improvements in terminology and nomenclature. 1500 w. *Elec Wld & Engr*—Oct. 20, 1900. No. 37212.

GAS ENGINEERING

Acetylene.

A New Acetylene Gas Generator. Illustrated description of an invention of Eugene Bournonville. 1400 w. *Eng News*—Oct. 4, 1900. No. 37006.

Some Facts About Purification of Acetylene Gas. Theodore Kautney. Read before the International Acetylene Assn. Shows that most of the troubles arises from impurities, and that getting rid of them will give a gas of superior quality. 1500 w. *Dom Engng*—Sept. 15, 1900. No. 36800 C.

The Best Method of Generating Acetylene; Water to Carbide, or Carbide to Water? J. A. Painchaud. Discusses the plunge system, and the sprinkling and immersion systems, advocating the carbide to water generators. 1000 w. *Ir Age*—Oct. 25, 1900. No. 37237.

Ammonia.

Sulphate of Ammonia in Comparison with Other Manures. James Muir. Considers the application of sulphate of ammonia on potatoes, beans, clover, grass land, etc. 4000 w. *Gas Eng's Mag*—Sept. 10, 1900. No. 36931 A.

Artificial Lighting.

The Development of Artificial Lighting. From the *Inst. of Civ. Eng's*. Summary of an interesting article by Herr C. Kjaer, which appeared in *Ingeniøren*, of Copenhagen. 1200 w. *Jour Gas Lgt*—Oct. 2, 1900. No. 37101 A.

Boule Light.

The Boule Light. Ernest Salzenberg. Read before the International Gas Congress, at Paris. Briefly reviews the methods of obtaining the heat energy of gas in the form of light, the apparatus used for increasing the light by means of increased pressure. 3800 w. *Jour Gas Lgt*—Oct. 2, 1900. No. 37099 A.

Burners.

Self-Lighting Gas-Burners. A review of articles by M. Pierron on the characteristics of some appliances for automatic ignition. Ill. 3000 w. *Jour Gas Lgt*—Oct. 16, 1900. No. 37252 A.

Calcium Carbide.

Calcium Carbide at the Congress of Applied Chemistry. Reviews papers on this subject read at Paris. 1600 w. *Sci Am*—Oct. 20, 1900. No. 37169.

Coal Gas.

Heating and Lighting Power of Coal Gas. T. Fairley. On some of the results obtained, and precautions needed to give trustworthy measurements. 900 w. *Am Gas Lgt Jour*—Oct. 29, 1900. No. 37297.

Coke Handling.

Mechanical Handling of Coke in the Paris Gas Company's Works. Abstract translation of paper by M. Louvel, giving illustrated detailed description of the plant. 3200 w. *Gas Wld*—Sept. 22, 1900. No. 36946 A.

The Mechanical Handling of Coal and Coke (*Manntention Mécanique du Charbon et du Coke*). J. Laverchère. A very complete illustrated account of the apparatus and methods at the works of the Paris Gas Company. Two articles, two plates. 6000 w. *Génie Civil*—Sept. 22, 1900. No. 37305 each D.

Consolidated Plant.

The Plant of the Faribault Consolidated Gas and Electric Company. Oliver Field Allen. Illustrated description of a plant in Minnesota. 2500 w. *Engs' Year Bk.*, 1900—Univ of Minn. No. 36963 E.

Consumers.

An Unprofitable Consumer. Norton H. Humphrys. Discusses the use of slot-meters, fuel gas, etc., and how to convert an unprofitable customer into a profitable one. 3700 w. *Jour of Gas Lgt*—Oct. 2, 1900. No. 37096 A.

Fuel Gas.

Culm Banks and Fuel Gas. Alton D. Adams. An estimate of the cost of gas developed from the anthracite coal culm, and transmitted 50 miles. 2200 w. *Sci Am*—Oct. 13, 1900. No. 37070.

Furnace Gas.

Heat and Power from the Waste Gases of Blast Furnaces. F. W. Gordon. Discusses what amount of heat should be used for the blast furnace, and what would remain. Ill. 4000 w. *Ir Age*—Oct. 18, 1900. No. 37157.

Practical Considerations Involved in the Generation of Power by Blast Furnace Gas. Particulars of its working and of the results obtained in practice. 2000 w. *Elec Rev, Lond*—Sept. 28, 1900. Serial. 1st part. No. 37014 A.

Gas Engines.

See Mechanical Engineering, Special Motors.

Gas Manufacture.

Practical Notes on Gas Manufacture. S. Carpenter. Notes and facts from experience intended for help of those who have not had a liberal education. 2400 w. *Jour Gas Lgt*—Oct. 2, 1900. Serial. 1st part. No. 37097 A.

Gas Power.

The Use of Motors with Lean Gas (*Emploi des Moteurs à Gaz Pauvre*). Charles Thonet. An examination of the advantages of producer and water gas for motive power, especially in electric power and lighting stations. 4000 w. *Rev Univ des Mines*—Sept., 1900. No. 37340 G.

Gas Stoves.

Faults in Gas Stoves for Heating Baths. A. Gartner. Investigations leading to the conclusion that gas stoves and bath heaters, without adequate ventilation, in small rooms, involve a direct danger to life.

2200 w. *Gas Engs' Mag*—Oct. 10, 1900. No. 37249 A.

Gas Supply.

A Sketch of the History of the Gas Supply of New York. The present article reviews the subject up to the close of the Civil War. 2800 w. *Jour Gas Lgt*—Oct. 2, 1900. Serial. 1st part. No. 37095 A.

Globes.

Welsbach Lamp Globes and Reflectors. Reports results of tests made as to the distribution and diffusion of light by different globes used in conjunction with Welsbach mantles. Robert Williamson and Henry Klinck, in the *Journal des Usines à Gaz*. Ill. 1000 w. *Gas Wld*—Sept. 29, 1900. No. 37018 A.

Illuminants.

The Use of Hydrocarbons as Illuminants in Competition with Gas. A. Lecomte. Read before the International Gas Congress, at Paris. Treats of lighting by volatile hydrocarbons, distributed at the ordinary temperature. 4200 w. *Jour Gas Lgt*—Oct. 16, 1900. No. 37251 A.

Illuminating Gas.

Manufacture of Illuminating Gas. The present article is an illustrated description of the methods used at the 14th St. Station. New York. 2700 w. *Sci Am*—Oct. 6, 1900. Serial. 1st part. No. 36929.

Illumination.

Systems of Illumination Graphically Compared. Ad. Bouvier. Read before the International Gas Congress, at Paris. Gives the facts to be expressed and explains how this is done graphically. 800 w. *Jour Gas Lgt*—Oct. 16, 1900. No. 37250 A.

The Illumination Problem Again. W. H. Birchmore. A criticism of various papers that have dealt with this subject. 2500 w. *Am Gas Lgt Jour*—Oct. 15, 1900. No. 37150.

Mantles.

The Incandescent Gas Mantle and Its Uses. Vivian B. Lewes. This first lecture reviews the development and history of mantles. 5200 w. *Jour Soc of Arts*—Oct. 19, 1900. Serial. 1st part. No. 37280 A.

Meters.

Dry Meters, Their Advantages and Defects. Abstract translation of paper by W. Asselbergs. Comparison of wet and dry meters, with illustrated description of the Haas meter. 2200 w. *Gas Wld*—Sept. 22, 1900. No. 36947 A.

Results with Prepayment Meters in Holland. P. Bolsius. Read before the International Gas Congress, at Paris. Particulars of results attending the adaption of this system. The general conclusion is favorable. 2500 w. *Jour Gas Lgt*—Sept. 25, 1900. No. 36978 A.

Wet and Dry Meters. P. Bigeard. Read before the International Gas Congress, at Paris. A discussion of the two methods, their advantages and disadvantages. 1500 w. Jour Gas Lgt—Oct. 2, 1900. No. 37098 A.

Paris Exhibition.

Gas-Generating Plant at the Paris Exposition. Brief description of a model exhibited in the German section at the Champ de Mars. 1100 w. Sci Am—Oct. 27, 1900. No. 37242.

Paris.

Public Lighting in Paris. Auguste Levy. Brief review, especially of recent work. 2200 w. Gas Wld. Oct. 6, 1900. No. 37132 A.

Price.

Governmental Control of the Price of Gas. Alfred E. Forstall. Read at Denver meeting of Am. Gas Lgt. Assn. Reviews the systems of regulation prevailing in various places. 4200 w. Am Gas Lgt Jour—Oct. 29, 1900. No. 37296.

Retorts.

Inclined Retorts at Cambridge. Richard Brown. Read before the Eastern Counties' Assn., England. Illustrated description of the installation and report of working. Also discussion. 4000 w. Gas Wld—Sept. 22, 1900. No. 36945 A.

Separate Gas Producers for the Heating of Retort-Benches. G. Eichebrenner. Read before the International Gas Con-

gress, at Paris. Illustrates and describes an installation near some coal mines, in grounds undergoing subsidence, and discusses the advantages and disadvantages of the system adopted. 1500 w. Jour Gas Lgt—Sept. 25, 1900. No. 36977 A.

Stokers.

Methods for Giving Stokers an Interest in Their Work. I. Hedde. Read before the International Gas Congress, at Paris. Considers the technical means, general methods of arousing interest, giving an account of the means employed and the proposed solution. 5500 w. Jour Gas Lgt—Oct. 2, 1900. Serial. 1st part. No. 37-100 W.

Water Gas.

Water Gas in Comparison with other Combustible Gases (Wassergas im Vergleich mit andern Brennbaren Gasen). Joh. Körting. An examination of gases used both for power and illumination, especially the former, showing under what conditions water gas may be advantageously used. Two articles. 7500 w. Zeitschr d Ver Deutscher Ing—Sept. 29, Oct. 6, 1900. No. 37328 each D.

On Water Gas. Henri Sospisio. Abstract of paper read at the Paris Congress. Discusses the Strache, and the Dellwik-Fleischer generators, and points of importance in the manufacture of water gas. Ill. 3000 w. Gas Wld—Oct. 20, 1900. No. 37288 A.

MARINE AND NAVAL ENGINEERING

Armor.

See Mining and Metallurgy, Iron & Steel.

Construction.

Changes in Vessel Construction in Forty Years of Lloyd's Register. B. Martell. Read before the Inst. of Naval Archts., London. A summary of the changes and developments in the construction of ships for the mercantile marine. 5800 w. Marine Engng—Oct., 1900. No. 37049 C.

Cruisers.

H. M. S. "Essex." Illustrated description, with comparison of the powers of offence and defence with the "Bayou" and "Prinz Heinrich." 2000 w. Engr, Lond—Oct. 12, 1900. No. 37222 A.

The German Armored Cruiser "Prinz Heinrich." Illustrated description, with comparison with other vessels. 1200 w. Engr, Lond—Sept. 21, 1900. No. 36956 A.

"Deutschland."

Additional Particulars of the New Transatlantic Record Breaker "Deutschland." Gives detail dimensions of the ma-

chinery and interesting views of the hull, with other information. 2000 w. Marine Engng—Oct., 1900. No. 37048 C.

Ferryboat.

New Type of Western River Ferryboat. William H. Bryan. From the official proceedings of the St. Louis Railway Club. An illustrated description of the "Andrew Christy," with review of types and progress. 4000 w. Naut Gaz—Sept. 27, 1900. No. 36904.

Freight Steamers.

Freight Steamers "Paraguay" and "Asuncion." Built on the Great Lakes for Atlantic Coasting Trade. Plans and brief description. 500 w. Marine Rev—Oct. 4, 1900. No. 37060.

French Navy.

The French Navy. A brief illustrated review showing the diversity of design and the unique character of the ships. 2000 w. Sci Am Sup—Oct. 6, 1900. No. 36930.

Great Lakes.

A Short History of the Lakes. Mary D. Hartt, in *Boston Transcript*. An ac-

count of the development of the great fresh water fleet on these lakes. 3200 w. Marine Rev—Sept. 27, 1900. No. 36906.

Marine Engines.

See Mechanical Engineering, Steam Engineering.

Merchant Marine.

German Merchant Marine at the Paris Exhibition. An illustrated description of the pavilion and the objects exhibited within, which represent the development of the German merchant marine during the last fifteen years. 4200 w. Engng—Oct. 12, 1900. No. 37185 A.

The Russian Mercantile Marine. Information from a report of the British Consul, with regard to the shipping of Odessa and the Russian mercantile marine. 1000 w. Engng—Oct. 5, 1900. No. 37111 A.

Rapid Fire.

Rapid-Fire Guns (Canons à Tir Rapide). G. Canet. A paper read before the French Society of Civil Engineers reviewing the progress made since the exposition of 1889. 3500 w. Mem Soc Ing of Civ de France—Sept., 1900. No. 37341 G.

Report.

Admiral Melville's Report. Abstract of report to the Secretary of the Navy, urging a liberal appropriation that will enable the U. S. to keep abreast with other naval powers, and indicating some of the needs. 3000 w. Ir Age—Oct. 25, 1900. No. 37-236.

Real Admiral Highborn's Report. Reviews this exhaustive report on the development of the navy. 1900 w. Marine Rev—Oct. 25, 1900. No. 37269.

Statistics.

Naval Statistics. Statistics of the four principal naval powers of Europe, with comparison. 3000 w. Engng—Oct. 12, 1900. No. 37186 A.

Ore Transportation.

Transportation of Lake Superior Ores. Waldon Fawcett. An illustrated account of the ore-carrying vessels, handling cargoes, railways, etc. 2200 w. Mod Mach—Oct., 1900. No. 36983.

Schooner.

A Five-Thousand-Ton Wooden Schooner. Illustration of what is believed to be the largest wooden sailing vessel ever built, the "Pretoria," of Bay City, Mich. 600 w. Marine Engng—Oct., 1900. No. 37050 C.

Shipbuilding.

Shipbuilding in Germany. George Crouse Cook. Illustrates and describes an ice-breaking pilot steamer building at

Kiel for service at the Kertsch, which connects the Black Sea with the Azof. 1800 w. Marine Rev—Sept. 27, 1900. No. 36-905.

Speed Trials.

Speed Trials of the New British Royal Yacht "Victoria and Albert." Report of recent trials, which were satisfactory. 800 w. Marine Engng—Oct., 1900. No. 37-045 C.

Steamships.

The Cunard Liner "Ivernia." Longitudinal section and deck plans, with brief description. 800 w. Engng—Sept. 21, 1900. No. 36948 A.

Submarine.

Submarine Boats—From the Earliest Records Down to the Present. Carl Burley. Translated from the Pro. of the German Soc. of Nav. Archts. and Marine Engs. Illustrated historical review. 2800 w. Marine Engng—Oct., 1900. Serial. 1st part. No. 37046 C.

Submarine Navigation (La Navigation Sous-Marine). H. Noalhat. A discussion of the space required for motors operated by steam, electricity, compressed air, and petroleum, respectively, for use in submarine boats. 1500 w. Revue Technique—Oct. 10, 1900. No. 37317 D.

Tugs.

New Steel Harbor Tug. Description of the "John K. Cowen," with illustration. 1000 w. Naut Gaz—Oct. 4, 1900. No. 37-001.

U. S. Laws.

U. S. Laws Regulating the Importation of Materials for the Construction and Repair of Vessels. Gives opinions and rulings in recent cases, and which are accepted as the law at the present time. 2500 w. Marine Engng—Oct., 1900. No. 37047 C.

Warships.

Modern Warships (Les Marines de Guerre Modernes). M. de Chasseloup-Laubat. An exhaustive review of the vessels of various naval powers. This issue covers the British navy. 20000 w. Bull Soc d'Encour—Sept., 1900. No. 37335 G.

"Wisconsin."

trates and describes the vessel, and reports Trial Trip of the "Wisconsin." Illustrates the fastest battleship in the American Navy. 2000 w. Marine Rev—Oct. 18, 1900. No. 37219.

Yachts.

Yacht Designing. Theodore Lucas. Briefly discusses the appearance, general arrangements, ornamentation, stability, strength, etc. 1400 w. Naut Gaz—Oct. 11, 1900. No. 36980.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Acetylene Motors.

Acetylene in Explosion Engines. Discusses the advantages and disadvantages of this gas in reference to its use for the propulsion of motor vehicles. 2100 w. *Auto Jour*—Sept., 1900. No. 36933 A.

Automobile Facts.

The Electric Automobile from a Commercial Point of View. Robert A. Fliess. The first part of a report aiming to determine as accurately as possible the commercial standing of the electric automobile at the present time. 6000 w. *Elec Wld & Engr*—Oct. 6, 1900. Serial. 1st part. No. 37051.

Construction.

Automobile Construction and Constructors. Thomas Clarkson. Discusses some of the difficulties met, the choice of motive power, wheel construction, etc. 2200 w. *Horseless Age*—Oct. 17, 1900. No. 37175.

The Final Automobile. Hugh Dolnar. The first of a series of six papers dealing with the primal mechanical requirements of automobiles. This paper considers permanent bearings. Ill. 4000 w. *Auto Mag*—Oct., 1900. No. 37211 C.

Electric Coupe.

Working Drawing of Electric Coupé. From *The Hub*. Shows how to construct the body, battery box and the gear in proportions to insure safety. 2000 w. *Sci Am Sup*—Oct. 20, 1900. No. 37173.

Exhibition.

The *Inter-Ocean* Tournament. E. C. Oliver. Reviews the exhibits of the automobile exhibition at Chicago. Ill. 1100 w. *Horseless Age*—Sept. 26, 1900. No. 36908.

Fire Automobiles.

The Electric Fire Automobiles of the Paris Fire Department. Brief illustrated description, including hook and ladder, fire-pump, and hose cart. 1200 w. *Sci Am*—Oct. 27, 1900. No. 37244.

Gasoline Motors.

Gasoline Automobiles. William Baxter, Jr. Illustrates and describes the principle on which gasoline motors act, and various applications to vehicles. 3400 w. *Pop Sci M*—Oct., 1900. No. 36976 C.

History.

The Genesis of the Automobile. A. Neuberger. Brief historical review showing the idea of mechanically propelled vehicles dates back to the time of the Pharaohs. 1300 w. *Auto Mag*—Oct., 1900. No. 37210 C.

Military.

The Automobile in Modern Warfare. From *L'Illustration*. Illustrates and describes the vehicles used in recent manoeuvres of the French army. The traction engines gave the most satisfactory results. 1000 w. *Sci Am Sup*—Oct. 13, 1900. No. 37071.

Motor Car.

The Rochet Motor Car. From *The Motor Car Journal*. Illustrated detailed description. 1200 w. *Sci Am Sup*—Oct. 27, 1900. No. 37247.

Paris Exhibition.

Automobiles at the Paris Exhibition. G. F. Desjaques. Gives a brief review of the automobile history of France, showing why steam has fallen into disfavor, as introductory to a very complete review of the interesting exhibits in this field. 3000 w. *Engng*—Oct. 19, 1900. Serial. 1st part. No. 37270 A.

The Paris Exhibition. Illustrated description of the more important exhibits of motor vehicles. 11800 w. *Auto Jour*—Oct., 1900. No. 37238 A.

Resistance.

Resistance of Road Vehicles to Traction. Abstract of a paper read by Prof. Hele-Shaw before the British Assn. On the need of investigation and proposed experiments, with brief report of preliminary experiments. 1700 w. *Auto Jour*—Sept., 1900. No. 36935 A.

Steam Truck.

The Cunningham Steam Truck. Illustrated description of a vehicle for heavy haulage. 2300 w. *Horseless Age*—Oct. 3, 1900. No. 36995.

Trials.

Heavy Motor Car Trials in Paris. An account of recent trials in which ten vehicles competed, comprising four steam cars, five petrol vehicles, and one electric van. Ill. 3800 w. *Engr, Lond*—Oct. 19, 1900. No. 37275 A.

Working Costs.

Some Actual Working Costs of Motors for Street Watering and Dust Removal. E. Shrapnell Smith. Read before the Assn. of Cleansing Supts. of Gt. Britain. Excerpt. A report of recent results justifying the use of motor vehicles for the purposes named. 2100 w. *Auto Jour*—Sept., 1900. No. 36934 A.

HYDRAULICS.

Hydraulic Power.

The New Hydraulic Electric Power Plant of Stuttgart at Marbach on the Neckar (*Die Neue Wasserkraft Anlage*

des Elektrizitätswerkes Stuttgart zu Marbach a. N.). Describing the plant by which 2,000 h. p. is generated at Marbach and transmitted about 12 miles to Stuttgart. 1000 w. Deutsche Bauzeitung—Sept. 29, 1900. No. 37371 B.

The Value of Water Power for Electrochemical Industries (Die Verwertung von Wasserkraften für Elektrochemische Zwecke). Oscar von Miller. A detailed analysis of the value of electricity in chemical industry, for water powers of various costs. 5000 w. Zeitschr f Elektrochemie—Oct. 11, 1900. No. 37370 G.

The Hydraulic Power of the Alps (Les Forces Hydrauliques des Alpes). René Tavernier. The very full report of the French government commission giving statistics, suggestions as to the utilization, and legislation, for France, Italy, and Switzerland. 25000 w. Map. Ann des Ponts et Chaussées—2 Trimestre, 1900. No. 37322 E + F.

Pump Foundations.

Suggestions Concerning Foundations. Henry H. Kelley. Illustrations and observations concerning construction and cost. 1200 w. Engr, U. S. A.—Oct. 1, 1900. No. 36928.

Water Lifting.

Advantages and Disadvantages of Various Motors for Raising Water to Elevations for Domestic Use. Discusses the windmill, the hydraulic ram, the electric motor, and the hot-air engine. 3300 w. Dom Engng—Sept. 15, 1900. No. 36889 C.

Water Motors.

Report upon Exhibits Class 20, at the Paris Exposition (Bericht über die Objekte der Klasse 20, "Diverse Motoren" an der Weltausstellung in Paris, 1900). F. Prasil. Especially devoted to the study of turbines and regulators exhibited at Paris. Serial. Part I. 3000 w. Schweizerische Bauzeitung—Sept. 29, 1900. No. 37332 B.

Wood Pipe.

Nine-Foot Wood Stave Pipe. Floriston Pulp and Paper Co., Floriston, Cal. D. C. Henry. Illustrated description of this pipe and its construction, and the power-plant supplied. 1200 w. Eng News—Oct. 4, 1900. No. 87007.

MACHINE WORKS AND FOUNDRIES.

Automatic Stop.

Adjustable Automatic Feed Release for Turret Lathes. Illustrates and describes an interesting adjustable device. 600 w. Am Mach—Oct. 25, 1900. No. 37234.

Cranes.

Electric Traveling Cranes in the Foundry. A. D. Williams. Read before the Foundry Men's Assn. Considers the multimotor electric crane from the user's

standpoint, its desirable and undesirable features. 3500 w. Ir. Trd Rev—Oct. 4, 1900. No. 36999.

The Stability of Locomotive Cranes. J. V. McAdam. Develops formulas for use and gives graphical plot for finding the weight of the crane. 1200 w. Sib Jour of Engng—Oct., 1900. No. 37180 C.

Files.

Making Chisels and Other Tools from Files. Walter J. May. Suggestions as to the proper treatment to secure good tools. 1400 w. Prac Engr—Oct. 12, 1900. No. 37205 A.

Gear Teeth.

The Bilgram Machine for Cutting Gear Teeth. Drawings and description, taken from letters patent recently issued. 2200 w. Ir Age—Oct. 11, 1900. No. 37068.

Lathes.

A Novelty in Lathe Design. Illustrates and describes a novel universal lathe made in Germany. 1800 w. Am Mach—Oct. 18, 1900. No. 37166.

Machine Driving.

See Electrical Engineering, Power Applications.

Mandrel.

Expansion Mandrel for Piston Rings. George R. Martin. Illustrated description. 300 w. Am Mach—Oct. 4, 1900. No. 36996.

Melting.

Hot Iron. Edward Kirk. The effects of rapid and slow melting are discussed, and the foundry sense of the term "hot iron." 1200 w. Foundry—Oct., 1900. No. 36959.

Pipes.

Pipe Founding. Eliot A. Keeler. Read at meeting of the Foundrymen's Assn. A review of American practice. Ill. 1600 w. Foundry—Oct., 1900. No. 36960.

Riveted Joints.

General Formulas for Efficiency and Proportions of Riveted Joints. John H. Barr. Considers single riveted lap joints, double riveted lap joints, double and triple riveted butt joints, two welts, and general equations. 1600 w. Sib. Jour of Engng—Oct., 1900. No. 37179 C.

Rolling Mills.

See Mining and Metallurgy, Iron & Steel.

Scrap.

Railroad Scrap. J. A. Carney. Discusses a method of handling machine-shop scrap from the time it is made until loaded for shipment. 1300 w. St. Louis Ry Club—Oct. 12, 1900. No. 37406.

Screws.

On Screw Threads Used in Cycle Construction, and for Screws Subject to Vi-

bration. O. P. Clements. Read before the British Assn. Discusses the shape of the threads. 1200 w. Engr, Lond—Sept. 21, 1900. No. 36958 A.

Shafts.

Repairing Multiple Eccentric Shafts. Walter J. May. Brief illustrated description of method. 700 w. Prac Engr—Oct. 19, 1900. No. 37283 A.

Sheet Metal.

Pressure and Power Required to Roll Sheet Metal. W. P. Richardson and E. K. Weimerlund. An account of experimental investigations. Ill. 1800 w. Eng's Year Bk., 1900—Univ of Minn. No. 36968 E.

Shops.

The Shops and Manufacturing Methods of the Hendey Machine Company. Illustrated detailed description of shops located at Torrington, Conn. 5400 w. Mach, N. Y.—Oct., 1900. No. 36911.

Steel Castings.

Steel Castings at the Exposition of 1900 (Les Aciers Moulés à l'Exposition de 1900). A. Abraham. A discussion of the present state of the art as shown by the exhibits at Paris, both of methods and products. Two articles, 4000 w. Génie Civil—Sept. 15, 22, 1900. No. 37302 each D.

Tubes.

Casting Solid Pipe Ingots for Drawing Tubes. Walter J. May. Suggestions that may be helpful in producing good castings. 1500 w. Prac Engr—Sept. 28, 1900. No. 37016 A.

Turret Lathes.

Turret Lathe Work at the Paris Exhibition. Reviews the most interesting of the exhibits and remarks on the degree of progress shown. Ill. 2300 w. Engng—Oct. 19, 1900. No. 37272 A.

Worm-Gearing.

The Action of Evolute and Cycloidal Teeth in Worm Gearing (Eingriffverhältnisse der Schneckengetriebe mit Evolventen und Zykloidenverzahnung). Ad. Ernst. A very full examination into the duration and nature of contact in various cases, with especial reference to the question of wear. Serial, Part I. 6000 w. Zeitschr d Ver Deutscher-Ing—Sept. 15, 1900. No. 37327 D.

MATERIALS OF CONSTRUCTION.

Aluminum.

Aluminum: Considered Practically in Relation to Its General Application in the Arts and Mechanics. Joseph A. Steinmetz. Enumerates the uses that have proved satisfactory and cautions the improper use of the metal. 4500 w. Jour Fr Inst—Oct., 1900. No. 36993 D.

Cast Iron.

See Mining and Metallurgy, Iron and Steel.

Rupture.

Deformation and Conditions of Rupture (Déformations et Conditions de la Rupture). Harel de la Noé. A mathematical examination of the behavior of solid bodies under stresses beyond the elastic limit, based upon the experiments of Commandant Hartmann. 8000 w. Ann des Ponts et Chaussées—2 Trimestre, 1900. No. 37323 E + F.

Specifications.

American Standard Specifications and Methods of Testing Iron and Steel. Albert Ladd Colby. Read before the Iron and Steel Inst. A critical review of the requirements, as indicated by American manufacturers. 7300 w. Ir & Coal Trds Rev—Sept. 21, 1900—No. 36953 A.

POWER AND TRANSMISSION.

Conveying Machinery.

"Otto" Wire Rope Tramway at a German Steel Works. Illustrated description of a rope tramway at the Hoesch Iron and Steel Works, Dortmund, for conveying coke to the blast furnaces. 800 w. Col Guard—Oct. 12, 1900. No. 37191 A.

Rolling Screw Conveyors. An illustrated discussion of the method of manufacturing spiral conveyors, and recent improvements made. 2000 w. Am Mach—Oct. 25, 1900. No. 37235.

Furnace Gas.

See Gas Engineering.

Power Generation.

Power Generation by Steam Engine, Water Turbine, and Gas Engine. Extract from paper by John B. C. Kershaw, read before the British Assn. The portion relating to gas-engines, and the conclusions of the writer. 1800 w. Jour Gas Lgt—Sept. 25, 1900. No. 36982 A.

Pulleys.

A Remarkable Test of a Wooden-Rim Pulley. Illustrated description of the construction of a pulley, and its test to a rim-speed of $5\frac{1}{2}$ miles per minute without destruction. 800 w. Eng Rec—Oct. 13, 1900. No. 37143.

SPECIAL MOTORS.

Acetylene Motors.

See Mechanical Engineering, Automobilmism.

Benzine Motors.

Studies in the Efficiency of Benzine Motors for Vehicles (Leistungsversuche an Fahrzeug-Benzinmotoren). Hugo Güldner. Giving details of the testing apparatus and data of tests upon benzine motors of motor cycles. Serial, Part I.

2500 w. Zeitschr d Ver Deutscher Ing—Sept. 29, 1900. No. 37329 D.

Gas Engines.

Fuel for Gas Motors. Aimé Witz. Read before the International Gas Congress, at Paris. Statements concerning the various gases used, and improvements made. 2000 w. Jour Gas Lgt—Sept. 25, 1900. No. 36979 A.

Gas Engine Design. E. J. Stoddard. Discusses the explosive mixture and ignition. Ill. 2200 w. Mod Mach—Oct., 1900. No. 36985.

Gas Engine Economy. E. W. Roberts, in *The Gas Engine*. Calling attention to needed improvements and means of securing the maximum economy. 1800 w. Min & Sci Pr—Oct. 5, 1900. No. 37077.

The Gas Engine of the Paris Exposition. Illustrated detailed descriptions of types exhibited. 4000 w. Power—Oct., 1900. No. 36923.

Gasoline Engines.

Gasoline Engines in the Philippines. Hints to exporters, illustrating changes made by native workmen, and the incorrect erection of the machines. 2100 w. Am Mfr & Ir Wld—Oct. 25, 1900. No. 37295.

Gas Power.

See Gas Engineering.

Internal Combustion.

Some Recent Developments in the Internal Combustion Engines. John A. Secor. Discusses progress in the use of gas and oil engines. Also general discussion. 11800 w. N. Y. R R Club—Sept. 20, 1900. No. 37119.

Paris Exhibition.

Gas and Oil Engines at the Paris Exhibition. Remarks on the leading types and a detailed description of the chief exhibits. 2800 w. Engr, Lond—Oct. 12, 1900. Serial. 1st part. No. 37221 A.

STEAM ENGINEERING.

Accidents.

Accidents with Steam Boilers in 1898 (Des Accidents d'Appareils à Vapeur Survenus pendant l'Année 1898). The official French tabulated report, with plates of details of explosions and other accidents. 5000 w. 3 plates. Ann des Ponts et Chaussées—2 Trimestre, 1900 No. 37324 E + F.

Can Boiler Explosions Be Prevented? W. H. Wakeman. Discussion of the causes of explosions, and precautions that should be taken. 3600 w. Mod Mach—Oct., 1900. No. 36984.

Boilers.

Feed Water and Boilers. A discussion of the nature of water supply, and a comparison showing that under certain conditions, one type of boiler may prove sat-

isfactory, while other types may not be adapted to the conditions. 1600 w. Locomotive—Sept., 1900. No. 37160.

Objectionable Matter Which Tends to Enter Steam Boilers, and Its Prevention from So Doing. W. W. Houfe. Read before the Inst. of Marine Engs. Deductions from the writer's experience. 2200 w. Prac Engr—Oct. 19, 1900. Serial. 1st part. No. 37282 A.

The Design of Tubular Boilers. Charles L. Hubbard. Plain directions from the standpoint of engineers and architects. 2300 w. Mach, N. Y.—Oct., 1900. Serial. 1st part. No. 36912.

The Joya Water Tube Boiler (Chaudière Aquitubulaire Système Joya). An improved boiler resembling the Niclausse, but with simplified connection of tubes. 1000 w. Revue Technique—Oct. 10, 1900. No. 37316 D.

The Steinmuller Boiler (Der Steinmuller Kessel). Especially devoted to a description of the Steinmuller exhibit at the Paris Exposition. 1800 w. Glaser's Annalen—Oct. 1, 1900. No. 37337 D.

Chimneys.

See Architectural Engineering.

Compound Engines.

Paris Exhibition—Compound Engine. Illustrated description of the new compound electric light engine exhibited by Robey & Co., Limited. 900 w. Engr, Lond—Sept. 21, 1900. No. 36955 A.

Cylinder Condensation.

Observations on an Improved Glass Revealer, for Studying Condensation in Steam-Engine Cylinders, and Rendering the Effects Visible. Bryan Donkin. General description, with account of experiments and results. Also a communication by M. Nadal. Ill. 6300 w. Inst of Mech Engs—Oct. 19, 1900. No. 37405 D.

Governors.

Note on Theory of Corliss Governors. C. V. Kerr. Explains a method of reducing the labor of finding the values of certain variables. 500 w. Stevens Ind—Oct., 1900. No. 37404 D.

High-Speed Engines.

High-Speed Reciprocating Engines. Allan Coats. Read before the Glasgow Tech. Col. Sci. Soc. A detailed study of this class, discussing in the present article the subjects of leakage, port design, lubrication, steam v. air buffers, etc. Ill. 4000 w. Elec Engr, Lond—Oct. 5, 1900. Serial. 1st part. No. 37125 A.

The Mertz High-Speed Steam Engines (Machines à Vapeur à Grande Vitesse Système E. Mertz). The Mertz balanced engine has two opposing pistons in each cylinder, enabling high speeds to be obtained without vibration. 1500 w. Génie Civil—Oct. 13, 1900. No. 37311 D.

Locomotive Boiler.

See Railway Affairs, Motive Power.

Marine Engines.

The Quadruple-Expansion Engines of the Cunard Liner "Ivernia." Illustrated description. 800 w. Engng—Oct. 5, 1900. No. 37110 A.

Pulverized Coal.

Burning Pulverized Coal. Describes the experiments being conducted by the Illinois Cent. Ry. Co., with apparatus for burning bituminous coal in a pulverized state, to ascertain whether the method would limit the smoke production and prove economical. Results are not yet available. Ill. 1500 w. Ry & Engng Rev—Oct. 6, 1900. No. 37056.

Pumping Engine.

Performance of the Twelve-Million-Gallon Allis Pumping Engine at Hackensack, N. J., and Comparative Data from Tests of the Best Three Contemporary Pumping Engines. James E. Denton. Gives a general description of the engine, states requirements, and gives results of tests. 3800 w. Stevens Ind—Oct., 1900. No. 37400 D.

Traction Engines.

American Traction Engines for Russia. Illustrated description of engines made in California, to be used as a substitute for camel trains in hauling supplies to the mines in Russia. 1000 w. Engr, Lond—Sept. 28, 1900. No. 37025 A.

Valve Gear.

See Railway Affairs, Motive Power.

Vertical Engines.

The 3,000-Horse-Power Engines of the Luisenstrasse Central Station, Berlin. Illustrated description from *Zeitschr d. Ver. Deutscher Ing.*, of three vertical, direct-connected, triple-expansion engines, with the results of a test of one of them, using steam with and without super heat. 2200 w. Eng Rec—Oct. 13, 1900. No. 37140.

MISCELLANY.**Aeronautics.**

Pegasus. Discusses the balloons of Count Zeppelin and M. de Santos Dumont. Ill. 2300 w. Auto Jour—Sept., 1900. No. 36932 A.

The First Two Trial Trips of von Zeppelin's Airship. Illustrations and brief account of ascensions and evolutions, showing advancement of great interest to aeronautics. 1600 w. Sci Am Sup—Oct. 27, 1900. No. 37246.

Education.

Training for Competition with the World. Presidential address of R. H. Smith before the Civ. and Mech. Eng. Soc., England. 6000 w. Engr, Lond—Oct. 5, 1900. No. 37118 A.

Engineer's Note-Book.

An Engineer's Private Note Book. John H. Gregory. Describes a method of preserving notes which permits their ready classification, binding, and duplication by blue-printing. 1300 w. Eng Rec—Oct. 13, 1900. No. 37144.

Induction Jets.

A New Theory of Induction Jets (*Nouvelle Théorie des Trompes*). A. Rateau. A mathematical and general discussion of the action of hydraulic jets for inducing currents of water or air, with the results of many experiments. An important paper. 15000 w. Revue de Mécanique—Sept., 1900. No. 37336 H.

Paris Exhibition.

The Paris Exhibition: Its Lessons and Suggestions for Engineers. Abstracts of papers read at meeting of the Manchester (Eng.) Assn. of Eng. 2000 w. Col Guard—Oct. 19, 1900. No. 37276 A.

Rotary Motion.

The Determination of Irregularities in the Motion of Rotary Machines by Use of the Tuning Fork (*Die Bestimmung des Ungleichförmigkeitsgrades Rotirender Maschinen durch das Stimmgabelverfahren*). F. Göpel. The vibrations of the fork give a determinate basis for comparison. Serial, Part I. 3500 w. Zeitschr d Ver Deutscher Ing—Oct. 6, 1900. No. 37330 D.

Specifications.

The Ways of Consulting Engineers and Contractors. W. H. Booth. Why some engineers will not allow a specification to be departed from in any particular. 900 w. Am Mach—Oct. 11, 1900. No. 37075.

MINING AND METALLURGY

COAL AND COKE.**American Coal.**

American Coal in Great Britain. Reprints of articles appearing in the British papers, in reference to the introduction of American coal. 1500 w. U. S. Cons Repts, No. 850—Oct. 4, 1900. No. 36991 D.

United States Coal in Marseilles. Extracts from the annual report of the consul, concerning the coal exported from America and other countries. 1500 w. U. S. Cons Repts, No. 850—Oct. 4, 1900. No. 36989 D.

United States Coal in Nantes. Consular report concerning this place as a market for American coal. 1200 w. U. S.

Cons Repts, No. 85—Oct. 4, 1900. No. 36990 D.

Anthracite.

The Anthracite Coal Trade. Waldon Fawcett. Figures on the output, showing its importance and the effect the strike may have on commerce. 2000 w. Am Mfr & Ir Wld—Sept. 27, 1900. No. 36922.

China.

Tong Colliery, Kaiping, North China. Thomas Webster. Read before the South Wales Inst. of Eng. Describes this colliery, the method of working, ventilation, haulage, etc. 3500 w. Col Guard—Oct. 5, 1900. No. 37114 A.

Coal Question.

The Burden of Coal. Benjamin Taylor. A detailed discussion of the coal question in England, showing its vital importance and where to look for relief. 5800 w. Nineteenth Cent—Sept., 1900. No. 36920 E.

Coke Handling.

See Gas Engineering.

Colliery Management.

The Relation of the Head and Colliery Offices. George Johnson. Brief description of methods and forms used in making reports. 800 w. Col Guard—Oct. 5, 1900. No. 37112 A.

Exports.

Coal Exports. Editorial on the present situation and the American coal question. 1700 w. Eng & Min Jour—Oct. 6, 1900. No. 37052.

Exposition.

Anzin Colliery at the Paris Exhibition. Describes the very interesting exhibit of this important French colliery. 3000 w. Col Guard—Oct. 19, 1900. No. 37277 A.

Vicoique et Noeux Collieries at the Paris Exhibition. Illustrated description of an electric locomotive and a compressed air hauling engine, with an account of the conditions they were made to satisfy. 3800 w. Col Guard—Oct. 12, 1900. No. 37188 A.

Fuel.

The Manufacture of Patent Fuel in Wales. Describes the agglomite process of manufacturing patent fuel from both the anthracite and bituminous mineral. 1500 w. U. S. Cons Repts, No. 85—Oct. 6, 1900. No. 36895 D.

India.

On the Makum Coalfield, Assam. George E. Harris. Read before the Manchester (Eng.) Geol. Soc. Describes these deposits, and reports the coal to compare favorably with best English coals. Also describes mining methods. 4000 w. Col Guard—Oct. 5, 1900. No. 37113 A.

Iowa.

Iowa Coal-Mining Methods. J. T. Beard. An account of the character of the coal, its influence on the methods of mining, and the systems in use. Ill. 1500 w. Mines & Min—Oct., 1900. No. 36882 C.

Italy.

Coal in Italy. Information concerning the sources of supply, and the amount of coal consumed. 900 w. U. S. Cons. Repts, No. 85—Oct. 4, 1900. No. 36988 D.

Michigan.

Pere Marquette Mines. R. A. Randall. Illustrated description of one of the largest and best equipped coal mines in the State of Michigan. 700 w. Mines & Min—Oct., 1900. No. 36875 C.

New Zealand.

The Puponga and Pakawau Coalfields, Collingwood County, N. Z. Alexander McKay. From the reports of the government geologist, giving an account of the coal-seams and analysis. 4000 w. N. Z. Mines Rec—Sept. 17, 1900. No. 37255 B.

The West Wanganui Coalfield. James Park. An account of the general geological structure and mineral resources. 3200 w. N. Z. Mines Rec—Sept. 17, 1900. No. 37256 B.

Philippines.

The Coal Fields of the Philippines. G. D. Rice. An account of extensive coal mines, some of which have been worked since 1827. The outlook for the establishment of gas works in the islands is favorably discussed. Ill. 3000 w. Am Gas Lgt Jour—Oct. 22, 1900. No. 37230.

Syndicate.

The Ten Years' Work of the Westphalia Coke Syndicate (Zehnjähriges Bestehen der Aktien-Gesellschaft "Westfälisches Kokssyndikat" zu Bochum). Reviewing the development of the coke industry in Westphalia, with instructive diagrams. 1200 w. 3 plates. Glückauf—Oct. 13, 1900. No. 37348 B.

Trams.

Colliery Trams. J. Fox Tallis. Read before the So. Wales Inst. of Eng. Calls attention to the various sorts and conditions of trams in use in the So. Wales coalfield, discussing their design. 2500 w. Ir & Coal Trds Rev—Sept. 28, 1900. No. 37023 A.

COPPER.

Analysis.

Volumetric Method for the Determination of Copper. Richard K. Meade. On the value of permanganate as a help to rapid analysis. 1000 w. Min & Sci Pr—Sept. 22, 1900. No. 36880.

Lake Huron.

Huronian Copper and Nickel. S. R. Clarke. Statement of the conditions and opportunities in Sudbury District. 1400 w. Am Mfr & Ir Wld—Oct. 4, 1900. No. 37058.

Montana.

Mining Practice in Butte, Montana, Copper Mines. R. B. Brinsmade. An account of the methods employed in the various operations, costs, etc. Ill. 4600 w. Mines & Min—Oct., 1900. Serial. 1st part. No. 36878 C.

Wisconsin.

Copper Mining in Northern Wisconsin. Kirby Thomas. Read before the Mining Congress at Milwaukee. An account of the geology, discoveries and developments in the western Lake Superior copper region. 1700 w. Mines & Min—Oct., 1900. No. 36877 C.

GOLD AND SILVER.**British Columbia.**

Similkameen Mining Division, Kamloops Mining District. W. M. Brewer. Description of this district, with other information related. 2800 w. Eng & Min Jour—Oct. 20, 1900. No. 37218.

Cape Nome.

The Great Storm at Nome. Winthrop Packard, in the N. Y. *Evening Post*. An account of a storm which wrecked a large part of the city. 1700 w. Eng & Min Jour—Oct. 13, 1900. No. 37153.

Cœur d'Alene.

Tunnel Development at Cœur d'Alene. W. C. Clark. A brief account of two cases of blind leads. 1000 w. Mines & Min—Oct., 1900. No. 36876 C.

Cripple Creek.

The Cripple Creek Mining District, Colorado. G. F. Hazlehurst. Geological map, with brief description of this district. 1100 w. Eng & Min Jour—Oct. 20, 1900. No. 37216.

Dredging.

Gold Dredging on Snake River in Idaho. F. Powell. Discusses the reasons for the numerous failures, the dredger used, cost, etc. Ill. 1800 w. Eng & Min Jour—Oct. 6, 1900. No. 37053.

The Saving of Fine Gold on Dredges. John Hayes. From the report of the Dept. of Mines on the Goldfields of New Zealand, for the year 1899-1900. Discusses the losses of gold in dredging, and means of overcoming the difficulty. 1500 w. N. Z. Mines Rec—Aug. 16, 1900. No. 36937 B.

Georgia.

Georgia Gold Mining Developments. Wilber Colvin. Historical review and re-

port of recent work. Ill. 1300 w. Eng & Min Jour—Oct. 6, 1900. No. 37055.

Idaho.

The Boise (Idaho) Basin Mining District. Robert Nye. The history of this district, its geology, deposits, and general information. 2300 w. Min & Sci Pr—Oct. 6, 1900. No. 37076.

Mexico.

The Mines of Guanajuato, Mexico. Clara Spalding Brown. Illustrated account of the mines and their working. 2000 w. Min Rept—Oct. 11, 1900. No. 37147.

Ores.

Ore Buying. F. Danvers Power. Showing that much of the supposed unfairness of the smelter is imaginary. 3300 w. Aust Min Stand—Sept. 20, 1900. No. 37254 B.

Placers.

Exploiting a New Placer Field. Arthur Lakes. Some of the considerations to be taken account of, as illustrated at Fairplay, near Alma, Colorado. Ill. 2200 w. Mines & Min—Oct., 1900. No. 36883 C.

Silver.

Silver. R. N. Osbiston. Read before the Inverell (N. S. W.) Assn. of Mines. The first part is introductory to a description of processes used to extract silver at the Inverell mines. 1200 w. Aust Min Stand—Aug. 23, 1900. Serial. 1st part. No. 37019 B.

South Carolina.

The Haile Gold Mines. Arthur Lakes. Describes the machinery used for concentrating the ores, and for roasting and treating them by the chlorination process. 2500 w. Mines & Min—Oct., 1900. No. 36879 C.

IRON AND STEEL.**Armor.**

Progress in the Manufacture of Armor Since 1889 (Progrès Réalisés dans la Fabrication des Blindages). E. Delmas. A review of the improvements due to the severe tests to which plates have been subjected, showing the great progress made in ten years. 2500 w. Mem Soc Ing Civ de France—Sept., 1900. No. 37343 G.

Bessemer Plant.

The Youngstown Bessemer Plant of the Republic Iron & Steel Company. Illustrated detailed description. 1100 w. Ir Age—Oct. 11, 1900. No. 37069.

Cast Iron.

The Influence of Aluminum on the Carbon in Cast Iron. Godfrey Welland and Harry W. Wardron. Read before the Iron & Steel Inst. An account of experiments to determine the amount of alumi-

num necessary to produce the maximum separation, and to ascertain the effect of slow and rapid cooling. Also discussion. Ill. 4000 w. Col Guard—Sept. 28, 1900. No. 37031 A.

France.

The Iron and Steel Industry of France. A report on the development and progress from 1888 to 1898. 3500 w. Ir Age—Oct. 4, 1900. No. 36924.

High Temperatures.

High Temperatures Produced by a New Method. Ernest F. Lange. Presented at the Paris meeting of the Iron and Steel Inst. A description of the Goldschmidt process. 4000 w. Ir Age—Oct. 4, 1900. No. 36925.

Limonite.

Limonite Ores of Pennsylvania. T. C. Hopkins. Their composition and forms, and an account of the various places in the State where they are mined. Ill. 3800 w. Mines & Min—Oct., 1900. No. 36874 C.

Ore Transportation.

See Naval and Marine Engineering.

Paris Exhibition.

Iron and Steel at the Mineral Exhibition, Paris, 1900. H. Bauerman. A paper prepared as a guide to members of the Iron & Steel Inst. visiting the exhibition. 4000 w. Engr, Lond—Oct. 12, 1900. Serial. 1st part. No. 37223 A.

Phosphorus.

Iron and Phosphorus. J. E. Stead. Read before the Iron & Steel Inst. An account of researches and report of results of much interest. 6800 w. Engng—Oct. 19, 1900. Serial. 1st part. No. 37273 A.

Rolling Mills.

Suggestions for the Improvement of Rolling Mills. Louis Katona. Read before the Iron and Steel Inst. Discusses defects of the present system, and the author's suggestions for a solution of the problem. 4000 w. Ir & Coal Trds Rev—Sept. 21, 1900. No. 36954 A.

Slag.

Blast Furnace Slag for Fertilizing. Alexander D. Elbers. Showing that it contains lime beneficial to the soil, and presenting the possible merits and essential points relating to its use. 2300 w. Am Mfr & Ir Wld—Oct. 11, 1900. No. 37102.

Solution Theory.

The Present Position of the Solution Theory of Carburized Iron. A. Stansfield. Abstract of paper read before the Iron & Steel Inst. Reviews the experimental evidence bearing upon this subject, and gives results of the writer's experi-

ments. Ill. 1700 w. Ir & Coal Trds Rev—Sept. 28, 1900. No. 37022 A.

Steel.

The Manufacture of Steel. A review of pre-modern methods of manufacture is given in the present article. 2400 w. Auto Jour—Oct., 1900. Serial. 1st part. No. 37239 A.

Steel Castings.

See Mechanical Engineering, Machine Works and Foundries.

Trade.

A View of the Iron and Steel Trade. Walden Fawcett. Condensed from a monograph issued by the Treasury Dept. Bureau of Statistics of the United States. 3700 w. Eng & Min Jour—Oct. 27, 1900. No. 37266.

MINING.

Accidents.

Mining Labor and Accidents for the Year 1899. Particulars as to the number of persons employed and accidents at the mines and quarries of the United Kingdom. Ill. 3800 w. Col Guard—Sept. 21, 1900. No. 36952 A.

Cage-Loading.

Hydraulic Cage-Loading and Unloading Apparatus. G. B. Stones. Abstract of a paper read before the Inst. of Eng. Illustrated description of the surface and underground arrangements. 1200 w. Col Guard—Oct. 12, 1900. No. 37192 A.

Explosives.

The Use of Explosives in Mines. A copy of a recently issued circular to mine-owners, relating to the use of explosives in coal mines, with a list of the permitted explosives that have passed "special test." 2400 w. Col Guard—Oct. 12, 1900. No. 37189 A.

Life Saving.

Life-Saving Apparatus in Mines (Minen-Rettungsapparate). Johann v. Laues. A general discussion of devices for enabling life savers to penetrate gaseous and burning mines. Two articles, 1 plate. 3500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 6, 13, 1900. No. 37345 each B.

Metal Mining.

American Metal Mining. Theodore F. Van Wagenen. The present article discusses the deposits of iron, their working and transportation. 2400 w. Min Rept—Oct. 4, 1900. Serial. 1st part. No. 37074.

Mine Examination.

How Mines Should Be Examined. O. H. Parker. The writer's views, given for the purpose of calling out discussion. 1600 w. Eng & Min Jour—Oct. 20, 1900. No. 37217.

Mine Transmission.

See Electrical Engineering, Transmission.

Mining Law.

Loss of Remedy for Wrongful Uses of Way Leave, etc. A report of cases tried by British law, and a discussion of the decisions. 2400 w. Col Guard—Oct. 12, 1900. No. 37187 A.

The Mines Law of Ontario. Archibald Blue. Read before the mining congress, at Milwaukee. The provisions of the law in regard to prospecting and the acquiring of mining locations, etc. 3500 w. Mines & Min—Oct., 1900. No. 36884 C.

Wrongful Abstraction of Minerals: Measure of Damages. Report of cases and decisions in British courts. 2500 w. Col Guard—Sept. 28, 1900. No. 37030 A.

Mining Plant.

See Electrical Engineering, Power Applications.

Mining Tools.

Mining Tools in the Philippines. George D. Rice. Illustrates and describes some of the crude types used by the natives. 1400 w. Eng & Min Jour—Oct. 27, 1900. No. 37267.

Ore Testing.

Experimental Ore Testing Works. Arthur Lakes. Means for determining the proper method to be used in treating ores from a new mine, and the importance of tests. 1500 w. Mines & Min—Oct., 1900. No. 36881 C.

Pits.

On a New Method of Sinking Pits by Machinery. Richard Sutcliffe. Read before the Manchester, Eng., Geol. Soc. Illustrates and describes Sutcliffe's pit-sinking machine, and gives an account of its operation. 5200 w. Ir & Coal Trds Rev—Sept. 28, 1900. No. 37021 A.

Power Plant.

The Boise Basin (Idaho) Power Plant. Theo. F. Van Wagenen. Illustration and description of the construction is given in part first. 1000 w. Min Rept—Oct. 25, 1900. Serial. 1st part. No. 37299.

Rock Drills.

Machine Mine Rock Drills on the Pacific Coast. A. E. Chodsko. Brief description of the rock drills obtainable in San Francisco, and some facts relating to their use. 2500 w. Min & Sci Pr—Oct. 13, 1900. Serial. 1st part. No. 37167.

Rotary Converters.

Rotary Converters for Mine Traction. Alton D. Adams. Favoring their use as avoiding disadvantages incident to different classes of generating apparatus, and those that result from a high working pressure. 800 w. W Elect'n—Oct. 20, 1900. No. 37231.

Ventilation.

Influence on the Air-Current of Water Falling Down a Shaft. Paul Petit. From a communication to the International Min. Cong., at Paris. An account of investigations made to ascertain the mode of action of water thus falling, and to determine the amount of influence it may have on the total depression or water gauge. Ill. 3700 w. Col Guard—Sept. 28, 1900. No. 37032 A.

The Effect of Contractions in Area of Passages in Mine Ventilation. Paul Petit. Abstracted from paper read before the International Cong., at Paris. An account of tests and experiments, with conclusions. 2700 w. Eng & Min Jour—Oct. 13, 1900. No. 37154.

Wages.

Wages in the Mining and Quarrying Industries. Reviews the report to the Board of Trade of Great Britain on changes in rates of wages and hours of labor, giving tables showing variations. 1600 w. Col Guard—Oct. 12, 1900. No. 37193 A.

Winding.

The Koepe System of Winding. John Georgory and John T. Stobbs. Abstract of paper read before the Inst. of Min. Engs. Illustrates and describes this system at the Sneyd Colliery, Burslem, giving data relating. 800 w. Col Guard—Oct. 5, 1900. No. 37115 A.

MISCELLANY.**Address.**

Presidential Address Before the Iron and Steel Institute, in Paris. On metallurgical progress in England and France. 3800 w. Engng—Sept. 21, 1900. Serial. 1st part. No. 36950 A.

Corundum.

On Two New Occurrences of Corundum in North Carolina. Joseph Hyde Pratt. Describes an occurrence in amphibole-schist, and another in a quartz-schist. 1800 w. Am Jour of Sci—Oct., 1900. No. 36962 D.

Petroleum.

Applications of Petroleum to Metallurgy and the Glass Industry. From *Le Génie Civil*. Illustrates and describes the Nobel smelting furnace, grate and reverberatory furnace; also the Quaruström portable forge and grate, and their applications. 2200 w. Sci Am Sup—Oct. 20, 1900. No. 37172.

Characteristics of California Petroleum. A. S. Cooper. Information regarding the constituents, characteristics, and other matters of interest. 3800 w. Min & Sci Pr—Oct. 13, 1900. No. 37168.

Paraffin in Russian Petroleum. A. A. Shukoff and N. S. Pantjucoff. From the *Petroleum Review*. A report of investi-

gations made by the writer. 900 w. Auto Jour—Oct., 1900. No. 37241 A.

The Geology of Petroleum (Zur Geologie des Erdöles). H. Höfer. An examination of the theory of Carll and a comparison of the conditions in Pennsylvania with those in various parts of Europe. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 13, 1900. No. 37346 B.

Philippines.

Mining in the Philippines. George D. Rice. Reports concerning the mineral deposits, and the interest being shown in them. 1500 w. Eng & Min Jour—Oct. 6, 1900. No. 37054.

Rare Metals.

Rare Metals and Minerals. J. Ohly. Considers metals found in nature in limited amounts, or whose production is combined with extraordinary difficulties. Among these, platinum, uranium, vanadium, tungsten and molybdenum. 3000 w. Ores & Metals—Oct., 1900. Special No. No. 37263 C.

Sardinia.

Mechanical Ore Preparation in Sardinia. N. Pellati. From a communication to the International Cong., at Paris. Describes some new appliances used in Sardinia, and little known outside of Italy. 1200 w. Col Guard—Oct. 12, 1900. No. 37190 A.

Tin.

Tasmanian Tinfields. H. Grant. An account of the Blue Tier, in Portland. 2200 w. Aust Min Stand—Sept. 13, 1900. No. 37264 B.

Tin Supplies. Editorial review of the situation, discussing values and activity in tin mining, sources of supply, etc. 1400 w. Engng—Oct. 19, 1900. No. 37271 A.

Zinc.

The Metallurgy of Zinc. J. Ohly. Brief review of past methods used in the production of zinc from its ores, and of those now in operation. 2400 w. Min & Sci Pr—Sept. 29, 1900. No. 36981.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in August. Detailed list and classified summary. 4000 w. R R Gaz—Oct. 5, 1900. No. 37010.

Train Accidents in the United States in September. Detailed list and classified summary for the month. 3500 w. R R Gaz—Oct. 26, 1900. No. 37265.

Wrecking.

Raising a Locomotive Fallen Into a Canal (Relevage d'une Machine Locomotive Tombée dans un Canal). Interesting illustrated account of the manner in which the locomotive was raised and the canal cleared. 1000 w. Génie Civil—Oct. 6, 1900. No. 37309 D.

FINANCIAL.

Statistics.

Statistics of the Railways of the United States in 1899. Reviews the last issues of Poor's Manual, and the Statistical Bureau of the Interstate Commerce Commission. 3000 w. Eng News—Oct. 11, 1900. No. 37106.

MOTIVE POWER AND EQUIPMENT.

Draft.

Draft Appliances. Showing how seriously the work of locomotives is affected by them. 1200 w. Loc Engng—Oct., 1900. No. 36918 C.

Electric Locomotive.

See Street and Electric Tramways.

Express Car.

Express Car for the Transportation of Horses. Drawings and description of specially designed cars for the N. Y. C. & H. R. R. R. 700 w. Am Engr & R R Jour—Oct., 1900. No. 36897 C.

Headlights.

Eyes and Headlights. On the value of strong headlights, with arguments for and against their use. 1500 w. R R Gaz—Oct. 12, 1900. No. 37094.

Journals.

Hot Journals. Translation of a review by Josef Grossmann, discussing the subject from the standpoint of oil pressures between bearing surfaces. Ill. 2400 w. Am Engr & R R Jour—Oct., 1900. No. 36899 C.

Locomotive Boilers.

The Cause of Foaming in Locomotive Boilers. C. Herschel Koyl. Explains many causes of boiler foaming. 2000 w. R R Gaz—Oct. 12, 1900. No. 37091.

Locomotives.

Acceptance Tests for Locomotives. Communications considering the advantages of such tests. Also editorial. 2900 w. R R Gaz—Oct. 10, 1900. No. 37184.

A Locomotive with "Helping Cylinders" at the Paris Exposition. Illustrates and describes a novel engine exhibited by a Munich firm. 800 w. Eng News—Oct. 4, 1900. No. 37005.

Compounds and Light Loads. Editorial discussion of the operation of compounds with light loads, and suggestions for mak-

ing the engines better adapted for all kinds of service. 600 w. Loc Engng—Oct., 1900. No. 36913 C.

Compound Express Locomotive (Locomotive Compound à Grande Vitesse). F. Barbier. A detailed examination of the powerful two-cylinder compound locomotive of the Hungarian State Railways, exhibited at Paris. 2000 w. 1 plate. Génie Civil—Oct. 6, 1900. No. 37307 D.

Design for Mogul Locomotive with Wide Fire Box. D. R. Sweney. Presents plan of engine as an attempt to supply a larger grate with as few experimental details as possible. 1000 w. Am Engr & R R Jour—Oct., 1900. No. 36900 C.

Express Locomotive with Superheater. Illustrates and describes a German locomotive at the Paris Exhibition, with a superheater arranged in the smoke box. It is intended to secure superheated steam for the cylinders, and is claimed to be an economical engine. 700 w. Loc Engng—Oct., 1900. No. 36916 C.

High-Speed Locomotive (Thuile System). Illustrated description of an exhibit of Messrs. Schneider & Co., at Paris, designed to haul trains of 100 to 200 tons, at a speed of 75 miles per hour on a level gradient. 600 w. Engng—Sept. 28, 1900. No. 37029 A.

Locomotive for the Eastern Railway of China (Locomotive des Chemins de Fer de l'Est Chinois). Illustrated description of two-cylinder compound engine built by the Fives-Lille Company for the Manchurian section of the Siberian Railway. 1000 w. Génie Civil—Sept. 15, 1900. No. 37303 D.

Locomotive Saloon for the London & South-Western Railway. Illustrated description of a novel inspection engine, combining a locomotive and saloon. 500 w. Engr, Lond—Sept. 28, 1900. No. 37026 A.

"Northwestern Type" Passenger Locomotive. Comparison with standard passenger engines on the N. Y. C. & H. R. R. R. Ill. 1800 w. Am Engr & R R Jour—Oct., 1900. No. 36896 C.

Road Tests of Locomotives. Gaetano Lanza. How to obtain the objects sought in making tests, the methods used, and matters important in securing accuracy. General discussion. 10500 w. Cent Ry Club—Sept., 1900. No. 37066 C.

The Efficiency of Modern High-Speed Locomotives (Die Leistungen Moderner Schnellzuglocomotiven). Rolf Sanzin. With diagrams of efficiency curves plotted from actual results with various engines and trains. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 28, 1900. No. 37318 B.

The Phleger Locomotive. C. H. Caruthers. Historical article describing this type as supplied to the Pennsylvania R. R.

from 1853 to 1860. 2000 w. Loc Engng—Oct., 1900. No. 36915 C.

The Thuile Express Locomotive (Locomotive à Grande Vitesse Système Thuile). L. Prevost. Illustrated description of powerful French express locomotive designed to make a speed of 75 miles per hour. 2500 w. 2 plates. Mem Soc Ing Civ de France—Sept., 1900. No. 37344 G.

Twelve-Wheel Wide Fire-Box Freight Locomotive—Buffalo, Rochester & Pittsburg Ry. Illustrations, dimensions and brief description. 600 w. R R Gaz—Oct. 12, 1900. No. 37093.

What One of the Large Locomotives Is Doing. Showing what is being done by a large engine and demonstrating the economy of large engines where there is load enough to warrant their use. 300 w. Ill. Loc Engng—Oct., 1900. No. 36914 C.

Wide Fireboxes and Large Driving Wheels. F. F. Gaines. Illustrates and describes a new design for passenger service on the Lehigh Valley Railroad. 1400 w. Am Engr & R R Jour—Oct., 1900. No. 36898 C.

Railway Wagons.

Failures in the Draw and Buffing Gear of Railway Wagons. George Tertius Glover. Contributed to the Inst. of Civ. Engs., England. Describes the arrangement of the gear often used, the causes of failure, methods of coupling, etc., in this article. Ill. 2000 w. Col Guard—Oct. 19, 1900. Serial. 1st part. No. 37-278 A.

Resistance.

Train Resistances. Lester Daniel. Some results, obtained by tests, and investigations and formulas. 1500 w. Engs' Year Bk., 1900—Univ of Minn. No. 36-967 E.

Measurement of the Tractive Force, Resistance and Acceleration of Trains. A. Mallock. Read before the British Assn. Short account of experiments recently made on electric and other railways. Ill. 1800 w. Engr, Lond—Sept. 28, 1900. No. 37028 A.

Snow Plow.

Snow Plow, Vermont Valley R. R. Illustrated description. 800 w. Ry & Engng Rev—Oct. 6, 1900. No. 37057.

Truck Frames.

The Stresses in Arch Bar Frames. George I. King. Results of investigations of the stresses developed in arch bars for diamond frame trucks. Ill. 3500 w. R R Gaz—Oct. 5, 1900. No. 37011.

Valve Gear.

Valve Gear for Four-Cylinder Compound Locomotives (Steuerung für Verbund-Lokomotiven mit Vier Dampfcylindern). A description of the Von Borries system, in which a single modified Walschaert gear serves for each pair

of cylinders. 800 w. Glaser's Annalen—Oct. 1, 1900. No. 37339 D.

PERMANENT WAY AND FIXTURES.

Dirt Handling.

A Record in Dirt Handling. Illustrates and describes methods used in widening banks and ballasting on the Kansas City Southern Railway, and of the appliances used. 4500 w. Ry Age—Oct. 12, 1900. No. 37152.

Mountain Railways.

A New Form of Rack Rail for Mountain Railways. Illustrated description of the form devised by Emil Strub for the Jungfrau Ry. 600 w. Eng News—Oct. 11, 1900. No. 37109.

Rails.

Recent Practice in Rails. Abstract of the discussion on rails at the London meeting of the Am. Soc. of Civ. Engrs. 2200 w. R R Gaz—Oct. 12, 1900. No. 37092.

Round Houses.

Round-House Construction. A discussion, containing communications from Thomas Appleton, W. H. Marshall, and others. 2500 w. Cent Ry Club—Sept., 1900. No. 37067 C.

Shops.

New Shops of the Hannibal & St. Joseph Railroad. Plans and description. 600 w. R R Gaz—Oct. 5, 1900. No. 37009.

Sleepers.

Steel Sleepers (Les Traverses d'Acier). An account of the experiences with steel railway-sleepers on the State Railway of Sumatra. 3500 w. Revue Technique—Sept. 25, 1900. No. 37314 D.

Tunnels.

See Civil Engineering, Construction.

Viaduct.

See Civil Engineering, Bridges.

STREET AND ELECTRIC TRAMWAYS

Berlin.

The Berlin Electric Elevated Road. An illustrated description of the latest practice in Germany in this branch of engineering. 4000 w. St Ry Jour—Oct. 13, 1900. No. 37088 D.

Carlisle, England.

The Electric Tramway System of Carlisle, England. Illustrates and describes a typical British installation. 1300 w. St Ry Jour—Oct. 13, 1900. No. 37089 D.

Comparison.

A Three-Year Comparison of Cable, Electric, and Horse Traction in New York City. 2500 w. St Ry Jour—Oct. 13, 1900. No. 37090 D.

Current Consumption.

The Average Consumption of Current in Electric Tramways (Der Mittlere Stromverbrauch von Elektrischen Strassenbahnen). K. Sieber. Developing a formula for practical use, and examples of its application. 3000 w. Elektrotech Zeitschr—Oct. 4, 1900. No. 37356 B.

Curves.

Connecting Curves on Electric Tramways (Uebergangskurven bei Elektrischen Strassenbahnen). K. Sieber. An examination of the resistance offered by curves on tramways, with reference to the consequent consumption of electric power. 1800 w. Elektrotech Zeitschr—Oct. 18, 1900. No. 37363 B.

Demerbe System.

Recent Tramway Construction: With Special Reference to the Demerbe System. William Dawson. Read at Bradford meeting of the Brit. Assn. for the Adv.

of Science. An illustrated description of the system named, with brief notes on other systems. 2500 w. Elec Rev, Lond—Sept. 28, 1900. No. 37015 A.

Electric Locomotive.

The Paris Exhibition—Electric Locomotive. Illustrated description of an electric locomotive intended for working a rack railway, as well as on smooth rails. 900 w. Engr, Lond—Sept. 28, 1900. No. 37027 A.

The Standard-Gauge Electric Locomotive Exhibited by the Allgemeine Elektrizitäts-Gesellschaft at the Paris Exhibition. Illustrated description of a locomotive designed for the haulage on branch lines and for shunting purposes. 2000 w. Elec Engr, Lond—Sept. 28, 1900. No. 37123 A.

Electric Motor.

The Electric Railway Motor. John Lundie. Sketches the duty required of an electric motor applied to railway traction, and discusses the method of rating the horse-power. 4200 w. St Ry Jour—Oct. 13, 1900. No. 37082 D.

Exposition.

Electric Transport at the Exposition (Les Transports Electriques de l'Exposition). Alfred Boudon. A very full account of the traveling platform and the electric railway at the Paris Exposition. Two articles, 1 plate. 5000 w. Génie Civil—Sept. 15, 22, 1900. No. 37301 each D.

France.

Electric Railway Practice in France. A. N. Connett. An illustrated account of the methods employed, the attention given

to tasteful construction in overhead work, and the general progress. 9500 w. *St Ry Jour*—Oct. 13, 1900. No. 37080 D.

Guard Wires.

See Electrical Engineering, Distribution.

Italian Railway.

Electric Traction on a Main Line Italian Railway. Enrico Bignami. Illustrates and describes the electrical equipment of the Lecco, Sondrio and Chiavenna line in the north of Italy, with a three-phase traction system, using induction motors on the cars. 2000 w. *Elec Rev*, N. Y.—Oct. 10, 1900. No. 37149.

Kansas City.

Pioneer Electric Railway Work in Kansas City. John C. Henry. Brief history of the early electric railroads. 2300 w. *Elec Wld & Engr*—Sept. 29, 1900. No. 36901.

The Street Railway Situation in the Two Kansas Cities. Illustrated description of this example of the best American practice. 6500 w. *St Ry Jour*—Oct. 13, 1900. No. 37079 D.

Limoges.

The Tramways of Limoges (Les Tramways de Limoges). M. Delage. A detailed account of the Limoges tramway system, giving details of construction, operation, and maintenance. 12000 w. 4 plates. *Ann des Ponts et Chaussées*—2 Trimestre, 1900. No. 37326 E + F.

Polyphase.

Polyphase Railway Apparatus and Methods. Louis Bell. Treats of the latest American practice in polyphase distribution, and the use of polyphase motors for railway work. Ill. 4200 w. *St Ry Jour*—Oct. 13, 1900. No. 37086 D.

The Burgdorf-Thun Polyphase Electric Railway. W. Rung. Translated from the Danish paper *Ingeniøren*. A statement of the advantages of alternating current for railway working, and an illustrated description of the new railway from Burgdorf to Thun. 1500 w. *Elec Rev*, Lond—Oct. 12, 1900. Serial. 1st part. No. 37207 A.

Power Station.

A Water-Power Railway Plant. W. N. Zurfluh. Illustrates and describes the power house of the Toledo & Maumee Valley Traction Company. 1300 w. *Am Elect'n*—Oct., 1900. No. 37062.

The Ninety-Sixth Street Power Station of the Metropolitan Street Railway Company, of New York City. Discussion of paper by L. G. Montony. 1700 w. *Pro Am Soc of Civ Engs*—Oct., 1900. No. 37261 E.

The Traction Power Plant of the Paris Exposition. Illustrated description of the sub-station on the Quai d'Orsay. 1200 w. *Elec Wld & Engr*—Oct. 20, 1900. No. 37213.

Resistance.

The Resistance of Iron Conductors to Alternating Currents (Ueber den Widerstand Eiserner Wechselstromleiter). C. Feldmann and J. Herzog. A mathematical investigation, with practical applications to the use of rails as return conductors in tramways. 3000 w. *Elektrotech Zeitschr*—Oct. 11, 1900. No. 37359 B.

Rolling Stock.

Cars and Car Service in Metropolitan New York. H. H. Vreeland. A review of experiences since 1893, the traffic conditions, and methods adopted. 3200 w. *St Ry Jour*—Oct. 13, 1900. No. 37083 D.

The Standard Cars of the Metropolitan Street Railway Company of New York. Thomas Millen. Illustrates and describes in detail the four standards used by the company, and devices that have been found convenient. 3400 w. *St Ry Jour*—Oct. 13, 1900. No. 37084 D.

Speed.

Speed on the London Undergrounds. Illustrates and describes the methods used on the Central London Ry., and gives tabulated records of time on this road and also on the District Ry., and the City and South London Ry. 1700 w. *Elec Engr*, Lond—Oct. 5, 1900. No. 37126 A.

Storage Batteries.

Storage Batteries in Electric Railway Power Stations. Edward L. Reynolds. Cites results now being obtained in the operation of several railways, thus showing the advantages. 1300 w. *Am Elect'n*—Oct., 1900. No. 37064.

Suspended Road.

The Barmen-Elberfeld-Vohwinkel Suspended Railway (Die Schwebebahn Barmen-Elberfeld-Vohwinkel). A very complete and fully illustrated account of this successful overhead electric railway, with details of construction. 15000 w. *Zeitschr d Ver Deutscher Ing*—Oct. 13, 1900. No. 37331 D.

Third-Rail.

The Electrical Equipment of the Albany & Hudson Railway and Power Company. Illustrates and describes some features of the electrical equipment of the longest and most important third-rail electric system in the world. 1200 w. *Elec Rev*, N. Y.—Oct. 17, 1900. No. 37181.

Underground.

Results of Experience with the Boston subway (Erfolge und Erfahrungen mit der Bostoner Unterpflasterbahn). Fritz v. Emperger. An examination of the Boston subway, with especial reference to underground railways in other cities. 5000 w. *Zeitschr d Oesterr Ing u Arch Ver*—Oct. 5, 1900. No. 37320 B.

WORKS MANAGEMENT NUMBER

THE ENGINEERING MAGAZINE

PREPARED BY THE FOREMOST AUTHORITIES OF AMERICA AND EUROPE
DESCRIBING THE METHODS OF THE WORLD'S GREATEST INDUSTRIAL LEADERS
GUIDING TO PRACTICAL SOLUTIONS OF THE PROBLEMS OF MODERN INDUSTRIAL MANAGEMENT
FOCALISING THE LITERATURE OF SUCCESSFUL MECHANICAL PRODUCTION

A HAND BOOK FOR WORKS MANAGERS

Presenting the essence of practical systems which have formed the topics of One Hundred Expert Articles in THE ENGINEERING MAGAZINE during the last four years, and covering the great problems of organisation, methods, machinery, and management of men.

JANUARY, 1901



LORD ARMSTRONG.

From a Late Photograph.

THE WORLD IS ITS FIELD.

THE ENGINEERING MAGAZINE

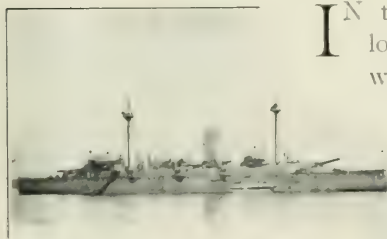
VOL. XX.

JANUARY, 1901.

No. 4.

LORD ARMSTRONG AND THE ELSWICK WORKS.

By Benjamin Taylor.



The Japanese Cruiser Naniwa, built at Elswick.

IN the "fairy tales of science and the long results of time" there is no more wonderful story than that of the industrial development of the world-renowned establishment which has grown up at Elswick, Newcastle-on-Tyne. "Armstrong's works," as they are popularly called, are the product of the last half of

the nineteenth century, and they express the highest attainments of that unexampled era of progress. It is scarcely possible to exaggerate the influence which this mammoth establishment has had upon engineering, the manufacture of ordnance, and war-ship building. It is certainly not possible to exaggerate the social importance of it to the city of Newcastle-on-Tyne, and indeed to the whole district of Tyne-side. Here are employed on the average an army of 25,000 workers, receiving every week something like £40,000 in wages to be spent and put in circulation in the neighbourhood. Here are turned out every

The Elswick works stand as the concrete revelation of the genius of their founder. In their intimate relation to naval expansion, in their sturdy conservatism in holding to the good until convinced of the better, and their splendid courage in progressive movement when convinced, they embody the dominant characteristics of British industry. Mr. Taylor discloses the spirit and method of the master-builder in the description of his work.—
THE EDITORS.

Copyright, 1900, by John R. Dunlap.

year millions of pounds' worth of steel and machinery, guns and ship-ping. The works, just on the western fringe of the city, have a river frontage upwards of a mile and a half long, from the steel works and ship-yards on the extreme east to the engine shops on the extreme west, with the foundries and ordnance department in between. All this has sprung from an idea which germinated in the fertile brain of a young Newcastle lawyer some sixty-five years ago. For Lord Armstrong, still the head of this great company, was born neither in the purple nor in the engine-room. He was only a country solicitor when he entered the battle of life, but he was endowed by nature with rare mechanical genius, with inventive faculty, and with phenomenal powers of penetration and foresight. When he went into engineering it was but a small works for making hydraulic machinery that he erected at Elswick, then a sort of rural retreat for Novocastrians. Opposite where now stands the great range of buildings of the Armstrong works was a long, low, verdant island called the "King's Meadow," sacred to the memory of picnics and boat-races. Many a famous race was "sculled" along that reach of shallow river, and many an aquatic contest has the present writer watched, as a boy, from points of vantage which he now seeks in vain to locate. Gone are the King's Meadow, the muddy, tide-forsaken shore, the shelving banks—gone with Harry Clasper and Bob Chambers and other heroes of the oar. The shallow stream is now a deep tidal river; in place of the swift out-rigger we find a wind-beating armoured cruiser; and for the cheers of the holiday crowd we have the ceaseless roar and hum of machinery. For one who can cast his mind's eye back even to the later sixties, the transformation at Elswick is marvellous. On the once more-or-less verdant banks he now finds a complete arsenal, more complete even than that of Woolwich or Essen; for at Elswick are made not only guns and projectiles of all sorts and sizes, but also the steel from which they are made, machinery of the highest types, and war-ships of all classes—everything, in fact, except gunpowder.

The engineering works date from 1847, having been commenced in that year by William (now Lord) Armstrong for the manufacture of hydraulic machinery. This is still a specialty of the establishment, though all sorts of engineering work is now done. The engineering works are at the west end of the establishment, and cover about 10 acres. Hydraulic cranes are the great feature of these works. You meet with them in all sizes and of many forms, but chiefly in three designs—all characterised by simplicity of mechanism and efficiency of action, fixed and movable, and with varying lifting

powers up to 160 tons. Here also is manufactured an immense amount of hydraulic machinery for docks, as, for instance, the gates for the Liverpool and Cardiff docks; hydraulic coal-shipping machines, which will lift 10-ton waggons a height of 30 feet and "tip" them down an iron chute in a minute and a half; hydraulic hoists of all sorts, capstans, pumps, winding engines, grain elevators, and other practical applications of water-power innumerable.



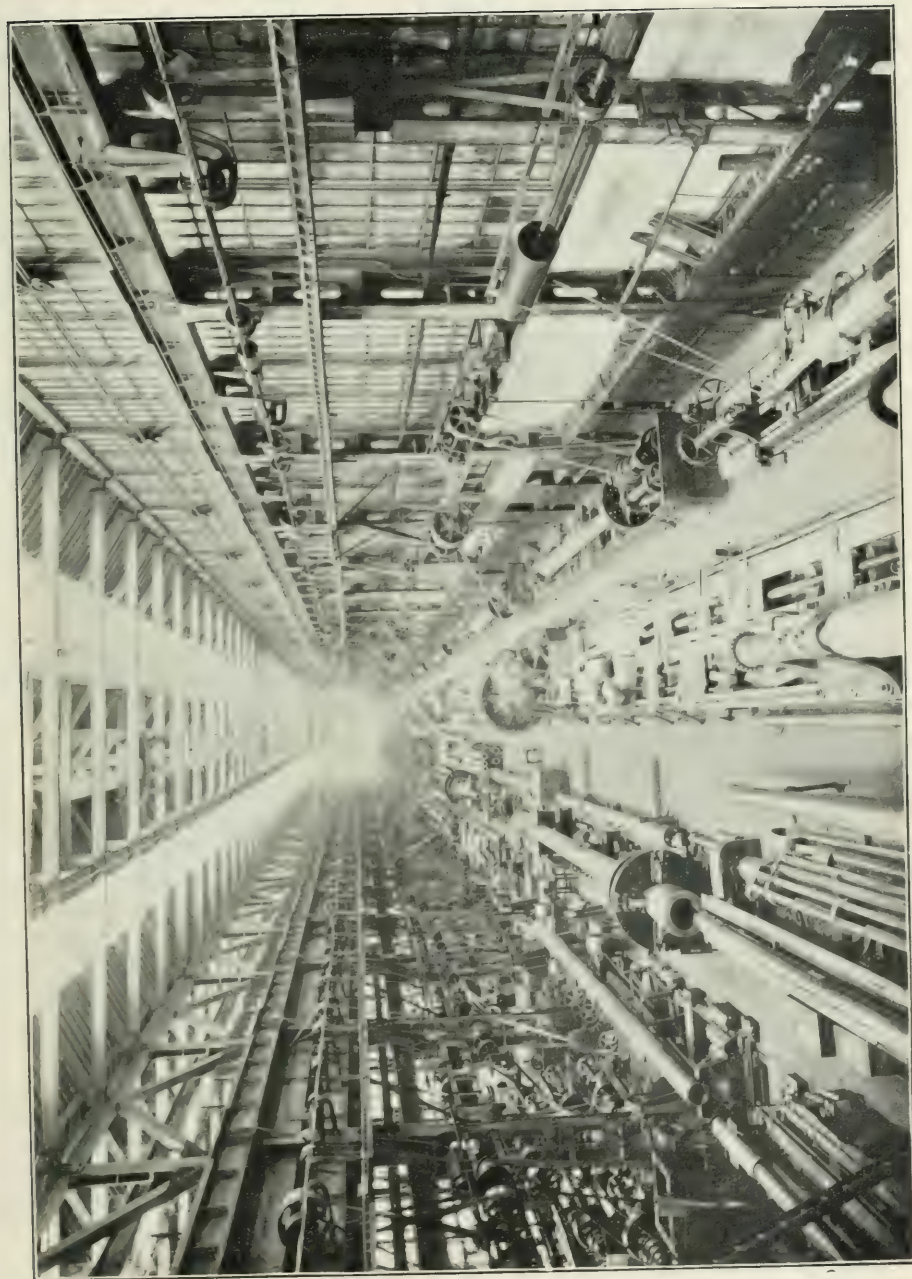
NO. 7 SHOP, ELSWICK WORKS

Many famous bridges have been turned out from these works, including the remarkable swing-bridge between Newcastle and Gateshead, the construction of which enabled the Armstrong company to undertake the building of large ships at Elswick. The first hydraulic riveting machine was made here some forty years ago, and is still, I believe, in use.

Hydraulic power is naturally extensively used in the machine tools of these great shops, where the saving of labour is carried to the height of a fine art. A feature in connection with the engine works is the enormous brass foundry. This, however, is about to be transferred to the extension works which the company are erecting at Scotswood, to the west of the Elswick establishment, and when this is done the present brass-foundry building will be made into an erecting

shop. The Armstrong company do not as yet build marine engines. Some twelve years ago they put up a couple of large shops for the purpose, but such was the run on them for ordnance that they had to use the buildings as gun shops, and have never since been able to turn them to their original purpose. These two shops are larger than any other engine shops in the country, though whether an easing off in the demand for ordnance will ever permit the building of marine engines in them is problematic. The whole of the engineering department is now under the management of Mr. H. O. Rendel.

At the east end of the Elswick works were, until last year, three large blast furnaces for the smelting of hematite ore, producing iron at the rate of over 2,000 tons per week for the company's own consumption. These furnaces, however, were pulled down in 1899, after a great fire in the works, and on the site of them has been built a large store in order to give more working space to the ordnance department, the former stores in which are now used as gun shops. The company are not now smelting iron, but propose erecting new and improved furnaces at the extension works which are being laid out at Scotswood, about a mile higher up the river. The Scotswood extensions will cover 30 acres and have a deep-river frontage and direct railway connection. Meanwhile, large stocks of pig iron are kept at Elswick ready for the insatiable steel furnaces, of which there are now eight of large size, the charges ranging from 15 to 40 tons per furnace. These steel works, which are about a quarter of a mile long and cover an area of 10 or 12 acres, were originally planned by the late Colonel Dyer, and were for a long time managed by him until he went to take charge of the company's works acquired from the Whitworth company, at Openshaw, Manchester. These works, being on sloping ground, are laid out in terraces—an arrangement which makes the regenerating chambers and valves more readily accessible. The character of the site involved great expense in construction, but the extra cost has, it is estimated, been more than compensated by the greater economy in working from level to level. Thus the upper terrace, just under the railway, receives the raw material, which is run along tracks carried on girders nine feet above the charging floor of the furnaces. The furnaces are on the second terrace, which is the melting floor, and there some 1,200 to 1,500 tons of ingot steel per week are turned out. There also are the circular gas producers for distilling from "duff" coal all the gas required for consumption in the steel furnaces; all the branches are connected by railway with one another, with the other parts of the works, or with the main railway.



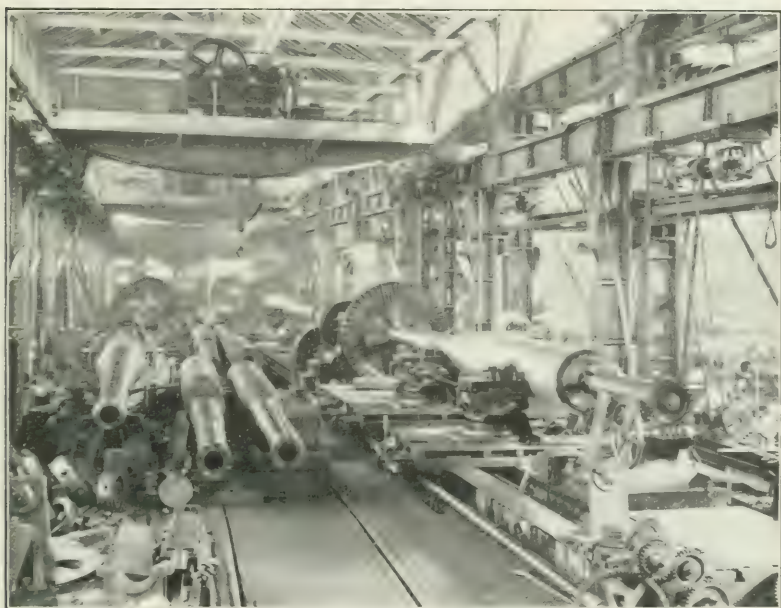
NO. 6 SHOT. TURNING, BORING, AND DRIFLING TUBES FOR LARGE GUNS.

On the third terrace is the forging shop, divided into three bays containing respectively the gas producers and reheating furnaces (fed by means of an overhead railway from the upper terrace), the forging press and cranes, and the large lathes and other machine tools for finishing. Between the second and third terraces is a retaining wall on which is carried a railway to serve the foundry and forging levels; and between the buttresses of this railway wall the spaces are filled with reserve supplies of coal. On the fourth terrace are the engines and boilers for driving the forging plant. The engines and pumps are interchangeable, so that, whilst each forging press has its own set, it can, in case of breakdown, be worked by any one of the others. The output of steel is about 50,000 tons per annum, and Elswick is in this comfortable position as regards its steel plant, that any ingots which do not come up to the standard necessary for ordnance can be at once absorbed in other departments of the works in uses for which their physical and chemical character may suit them.

In the steel works are many most interesting contrivances for saving labour and for handling heavy masses. The powerful travelling cranes are a special feature, and these were all made in the Elswick works and are operated by hydraulic power. By these, great masses of glowing steel from the furnaces are turned and manipulated as quick as thought at the touch of a lever by the forgerman. In the forging shop has been turned all the famous propeller shafting that Elswick has supplied to a perfect fleet of British and foreign war-ships. Single ingots have been cast weighing 85 tons, and propeller shafts have been forged upwards of 80 feet in length. To handle such masses very powerful and very perfect machinery is required. Here, for instance, are four great hydraulic presses exerting a pressure up to 5,000 tons. The pressure is supplied by five pairs of Corliss pumping engines, each of 1,000 horse power. There is a special foundry for castings for gun-carriages, marine works, stem and stern posts, rudder frames, and the like. The machine tools for turning and boring forgings and for cutting bolts, ingots, etc., are among the most powerful and delicate in the world. Quite recently two large presses of exceptional power have been added. And here it may be incidentally mentioned that a 12,000-ton press (one of the most powerful constructed) has recently been added to the company's works at Openshaw, Manchester. It was these last-named works that Colonel Dyer (who had been connected with the ordnance works of Sir Joseph Whitworth & Co. before he went to Elswick, and before the amalgamation of the two companies) was superintending at the time of his

lamented death. Colonel Dyer was President of the Federation of Engineering Employers during the memorable strike of 1897-1898.*

The ordnance department is the greatest feature of the Elswick establishment and the main cause of its greatest development. It was the mountain streams of Yorkshire that gave to young Armstrong the idea of utilising the natural force of water for mechanical purposes in hydraulic machinery. It was the Crimean war and the incidents in connection with artillery therein that gave him the idea which found expression in the rifled, coil-built, and breech-loading weapon known as the "Armstrong gun."



NORTH BAY, NO. 11 SHOP, ELSWICK. TURNING MEDIUM-SIZED GUNS.

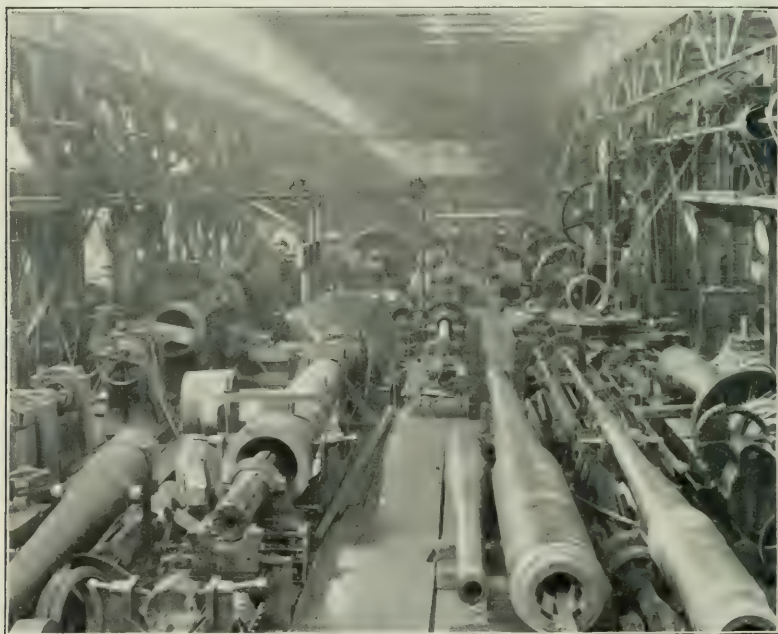
Shows the ample provision of travelling cranes serving the shop floor.

He began to make these guns at Elswick two years before they were adopted by the British Government in 1859, and then, having inaugurated a revolution in ordnance, for two or three years he superintended the Government gun factories at Woolwich, while these factories were being reorganised for the manufacture of the new style of gun. Thereafter the Elswick concern entered into an arrangement to

* The Openshaw works do not come within the purview of the present article. They are, however, a very important part of the Armstrong-Whitworth enterprise. Very great extensions have been and are being made to them, including a department for the manufacture of armour plates for the war-ships built at the Elswick ship-yard.

manufacture for the War Office; Mr. Armstrong was knighted for his great invention, and he associated with himself, as director of the ordnance department of the Elswick works, Captain (now Sir Andrew) Noble, R. A., formerly gunnery instructor at Woolwich and later renowned for his researches into the composition and properties of various explosives.

The ordnance department over which Sir Andrew Noble still presides is a vastly different place from the gun factory which Capt. Noble went to take charge of forty years ago. It covers over 40 acres and gives employment to some 14,000 men, working night and day in peaceful industry for the pursuit of war. It is indeed a town in itself, with more than the population of many an American "city." It is impossible to enumerate all the spacious shops and sheds stacked with giant masses of steel, throbbing with Titanic machinery, and stored



MIDDLE BAY OF NO. 11 SHOP. CUTTING RIFLING GROOVES AND BREECH-PLUG SCREWS IN HEAVY GUNS.

with huge guns of varying greatness in various stages of construction. Here one sees constructive ingenuity of the keenest type employed in evolving destructive machinery of the most deadly character. Here the moralist may find inexhaustible food for thought (if, indeed, he can collect his thoughts at all in the whirr and tangle of some of the

most beautiful and complicated machinery ever devised by human skill) in this seething hive of life whose mission is the pursuit of death. But for the mechanician, the economist—even for the Morleyan “plain man”—a walk through these wonderful shops is a liberal education in itself.

Putting aside the object of the article manufactured, we find at every turn the highest examples of applied mechanics and scientific insight. It is not the purpose of this paper to describe the process of gun-making, but only to give a general sketch of one of the most remarkable evolutions of inventive genius and administrative efficiency that the world has ever seen. It would need a volume to describe the manifold operations in casting, forging, boring, rifling, wire-winding, chambering, and otherwise perfecting, from a raw-steel ingot, the latest pattern of Elswick gun and its complete equipment of hydraulic machinery for mounting and service. The principle now adopted of building up the gun by winding and welding ribbons of steel around the cylinder requires the employment of tremendous lathe-power, and the enormous masses to be moved about the workshop in the various processes of machining require the employment of powerful cranes capable of lifting and travelling with a weight of 100 tons.

The original “Armstrong gun,” the first design of which Mr. Armstrong submitted to the War Office in 1854, has long been obsolete; but in the place of its birth we find the development of the principle it embodied, in the famous 4.7-inch and shapely 12-pounder quick-firing guns which may be said to represent the two highest types of present-day ordnance. But, of course, the 4.7-inch is not the largest gun made at Elswick by any means. The 8-inch is a quick-firer also, throwing four rounds of projectiles weighing 230 pounds each in 65 seconds. It has, however, found more favour in foreign navies than in the British service, in which a 9.2-inch gun has been preferred, while for British battle-ships, wire or ribbon guns of 12-inch calibre are now being forged. One brief comparison will illustrate the development of the last half century. The 6.3-inch 32-pounder of 1850 had a velocity of 1,600 feet per second and an energy of 570 foot-tons. The 6-inch quick-firing gun of 1900 has a velocity of 2,570 feet per second and an energy of 4,580 foot-tons, besides infinitely more rapidity of fire and accuracy. Perhaps the most interesting portion of the whole process of gun-making is the rifling, and it is just here that the most delicate manipulation and most perfect machine tools are required. The process occupies from a week to a month, according to the size of the gun, and at any moment during the

process the slightest deviation of the cutter from its true course may render useless many thousands of pounds' worth of material and labour.

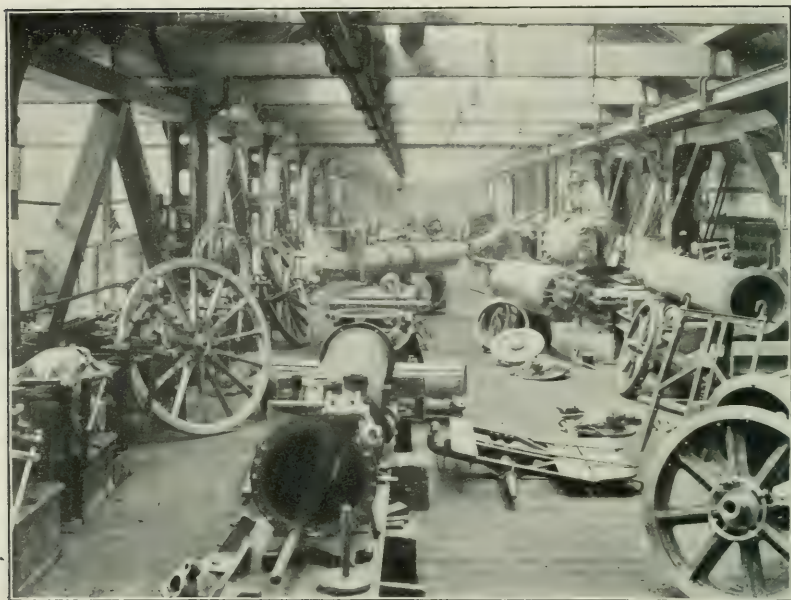
The Elswick ordnance works turn out about 6,500 tons of guns and mountings per annum, though a 10-inch gun takes a year to make, and a 110-ton gun about 18 months. In these workshops are more than four thousand machines of all sorts. The big guns, when finished, are tested on a moor to the west of Newcastle possessed by the company, and then sent for a course of experimental firing at a tidal range at Silloth.

The Armstrong company first became ship-builders in 1882, when they amalgamated with Messrs. Charles Mitchell & Company, at whose yard at Walker-on-Tyne had previously been built the numerous war-ships whose armaments were provided at Elswick. This amalgamation was a good stroke of business for the Elswick company, and the old-established and highly-equipped Walker yard is now, I believe, utilised for the building of merchant craft only, up to the highest type. The removal of the old low-level bridge between Newcastle and Gateshead, the construction of the swing-bridge already referred to, and the deepening of the Tyne above-bridge with the removal of the King's Meadow Island, enabled the company to begin ship-building at Elswick. At the east end of the establishment there were laid down berths primarily designed for the construction of war-ships. This department was for a time under the charge of Sir William White, who on being appointed Director of Naval Construction for the British Admiralty was succeeded by Colonel Philip Watts, under whose able management the Elswick war-ships have acquired world-wide fame. The many wonderful cruisers now afloat under various foreign flags that are peculiarly associated with Elswick, as well as the great Japanese battleship *Yashima*, are from the designs of Colonel Watts. And to Colonel Watts the writer has to express his grateful acknowledgement for kind assistance in the preparation of this article.

The first thing that impresses a visitor to the Elswick ship-yard is the stupendous character of the work in progress; the next is the admirable manner in which the area is appropriated, not an inch of space being wasted and all the sections being arranged for the minimisation of labour. The yard covers some 16 acres and has a river frontage of 2,000 feet, with ample depth of water at high tide for the biggest ironclad. It was a difficult site to utilise owing to "the lay of the land," but difficulties do not exist long at Elswick. The piling of the berths set apart for the building of heavy war-ships was necessa-



U. S. S. ALBANY, BOUGHT COMPLETE FROM THE ELSWICK WORKS BY THE UNITED STATES GOVERNMENT AT THE OUTBREAK
OF THE SPANISH-AMERICAN WAR.



NO. 16 SHOP, ELSWICK. ASSEMBLING RAPID-FIRE GUNS AND TORPEDO TUBES.

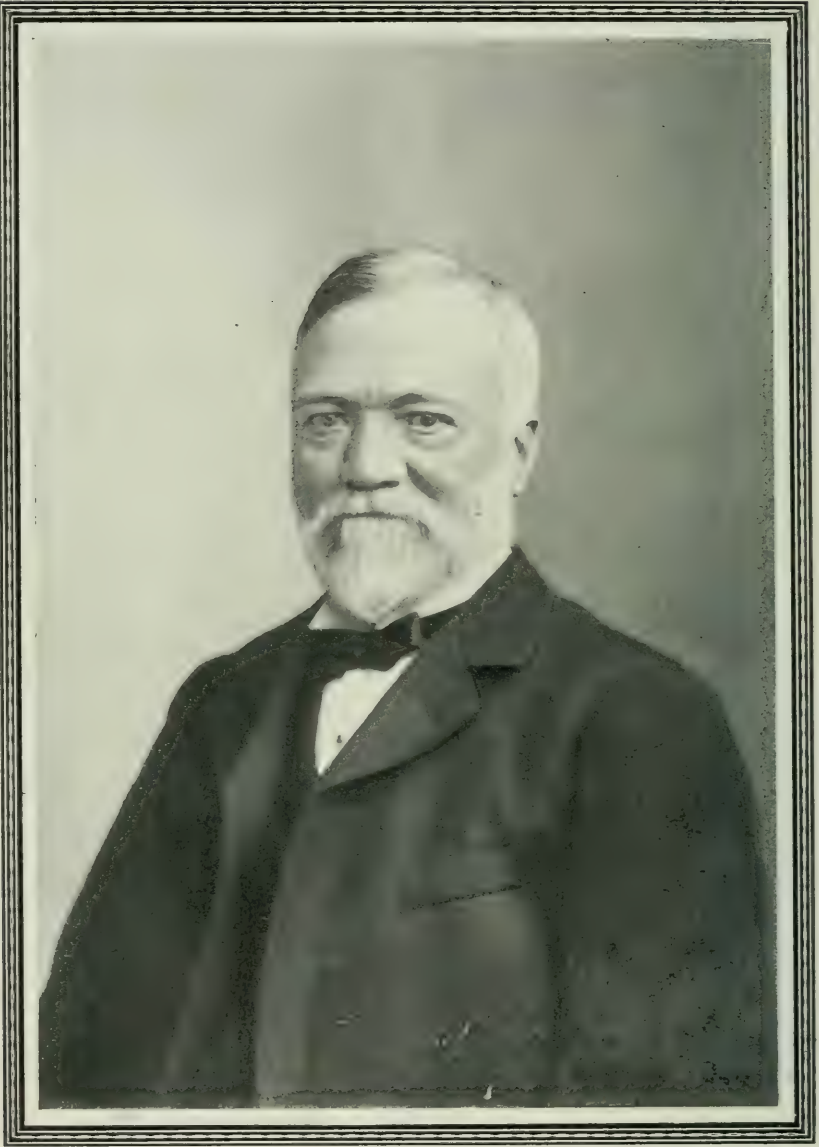
rily very costly, but consider what magnificent monsters have been evolved there! The first war-ships built at Elswick were, I believe, for the Austrian navy, but since then almost every navy in the world has been recruited there, sometimes to the specifications of the buyers, but more often to the design of Colonel Watts himself. Among them have been the famous Chilian armoured cruisers O'Higgins and Esmeralda, the Italian cruiser Piemonte, the Argentine cruiser Buenos Aires, and the Japanese cruisers Naniwa, Asama and Tokiwa. But space is not available even to enumerate the many war-ships built, fitted, and armoured at Elswick, much less to describe their special characteristics and the remarkable evolution in war-ship design. The work of building and fitting out war-ships is here carried on in every detail, from the drawing of the plans and laying down the moulds in the drafting loft to the completion of the armament. Great cranes carry and dispose enormous armour plates as easily as if they were feathers, and when the ship leaves the slip, she is ready to be hauled along to the other departments to receive her machinery and ordnance. One shop is devoted to the manufacture of dynamos and electric-lighting apparatus. In brief, it may be said that the characteristics of the war-ships now turned out at Elswick are high speed combined with efficient protection and the most powerful armament. In

point of equipment the ship-yard is one of the finest in the world. At a recent meeting of the Institution of Naval Architects Sir Edward Reed said: "No doubt the exceptional and paramount position of the Elswick works is due to the circumstance that it has been constantly progressing in connection with ships and guns and gun-mountings."

The note of the establishment is in fact, Progress, and its effort not merely to keep abreast but ahead of the times. Thus it occupies a unique position in the world—a complete arsenal in itself, initiated and conducted by private enterprise alone. We say a complete arsenal, for here a war-ship can be designed, built, armoured, fitted with engine and boiler, furnished and equipped with guns, ready to proceed straight out to sea and engage with an enemy in the offing, if need be. Of no other arsenal in the world can this be said.



Elswick-Built Cruiser *Piemonte*, of the Italian Navy,
Leading Fleet Evolutions.



ANDREW CARNEGIE.

THE HUGE ENTERPRISES BUILT UP, BY ANDREW CARNEGIE.

By Charles M. Schwab.



IT would seem a work of supererogation to present, in a succinct sketch of Andrew Carnegie such as this aims to be, the chronology of his life at length; for many biographers have made familiar the very interesting story of his notable career, from his humble origin through three-score and five years, showing the subject in his successive

stations as the bobbin boy, telegraph messenger, telegraph operator, railway superintendent, manufacturer, and philanthropist.

Much less relevant would be the rehearsal of all the many striking incidents of Mr. Carnegie's life, particularly during his boyhood struggles, in a retrospective survey of the quarter century of his life during which he has been *facile princeps* in the development of the American iron and steel industry and in placing the United States foremost of all the nations in that important branch of manufacturing.

Mr. Carnegie's advent into the field of metallurgy followed his retirement from the office of superintendent of the Pittsburg division of the Pennsylvania Railroad. That was just thirty-six years ago, when, it may be said, he was a young man, albeit he will doubtless resent the imputation that he is not still in the heyday of youth. The office of superintendent of the Pittsburg division was not, during Mr. Carnegie's incumbency, the sort of fat satrapy it is to-day, and his emoluments were beggarly (\$1,750 per annum) compared with

The influence and the service of Mr. Carnegie's stupendous work as an iron-master can not be defined by any national measure. Steel is the prime necessity of all mechanical manufacture and of practically all constructive work. It is the foundation of engineering expansion and of industrial growth. The man who makes steel cheap and abundant ministers to the whole of material civilisation, and the benefits he brings go hand-in-hand with his product through the world's work-shops. The Carnegie plant is not only an example of management on a Titanic scale; it is the foster-father of a vast company of metal-working establishments within whose reach it has put the substantial element of industrial prosperity—cheap raw materials.—THE EDITORS.

those of "R. P.," as my distinguished friend, Mr. Robert Pitcairn, the present Pittsburg head of the Pennsylvania, is popularly apostrophized. Mr. Carnegie had, moreover, invested the little he had in Adams Express Company's stock and a share in the famous Storey oil farm, so that when the Cyclops Iron Works, the primordial Carnegie enterprise, was decided upon, the founder, reluctant to disturb these small investments, was obliged to borrow his share (\$1,250) of the funds needed to finance the undertaking.

The Cyclops company was formed October 14, 1864, to establish an iron rolling mill to supply material to the Keystone Bridge Company, which was organized six months later. Mr. Carnegie resolved upon these ventures while in the service of the Pennsylvania, as a result of successful experiments the railroad company had made with an iron bridge. He foresaw the great possibilities for the iron trade in this direction, and with the self-reliant initiative which has ever characterized his life set about to establish himself with others in the business. The organization of the bridge company marked an important epoch in the railroad development of the country and the progress of the iron trade. It was precursory to the general substitution of metal for wood and masonry in railway-bridge construction and to the opening of a new and prolific realm to the nascent iron industry.

Associated with Mr. Carnegie in the foundation of the Cyclops plant, which, as its name imported, was really a prodigious enterprise for those uncertain days of civil strife, were Aaron G. Shiffler, J. L. Piper, Thomas N. Miller, Thomas Pyeatte, and John G. Matthews. The Keystone company included Aaron G. Shiffler, John L. Piper, Walter Katte, and James Stewart. About the same time the Union Mills, built in 1861-2 by Kloman & Phipps, were acquired by a company including Andrew Carnegie, Thomas N. Carnegie, Henry Phipps, Jr., Andrew Kloman, Gustavus Praetsch, J. L. Piper, Aaron G. Shiffler and Thomas N. Miller. Of these pioneers Mr. Phipps alone remains to share with Mr. Carnegie the fruits of the sapling which they planted nearly four decades since. The growth of that sapling has been phenomenal and incessant, being comparable now only with the gigantic redwood of the California coast ranges, a marvel of size and strength. More fitting names than Cyclops, Keystone, and Union could not have been given to the enterprises upon and around which the various concerns comprising The Carnegie Company of to-day were reared.

The Keystone company built the first 300-foot span metal bridge over the Ohio and has since erected many of the largest steel struc-

tures throughout the country. The business expanded rapidly during the boom in railroad building after the American civil war and received a great impetus when steel was adopted for building purposes. Soon after these works began operation, it became necessary to provide an independent source of pig-iron supply, and the Lucy Furnace Company was formed and built a small stack which was blown in May 11, 1872.

The manufacture of steel by the Bessemer process was taken up in 1874, the Edgar Thomson Steel Company, Limited, being organized by Mr. Carnegie and others for that purpose. This company was capitalized at \$1,000,000 and built a plant for rolling rails, consisting of a Bessemer converter and a rail mill. The American steel-rail industry was then about seven years old, and, under the Morrill and supplemental protective tariffs had attained considerable proportions, although imports continued from England. The Illinois, Pennsylvania, Cambria, and Bethlehem companies had entered the trade in the order named between '65 and '73, but it was not until 1867 that home-made Bessemer-steel rails were laid for the first time in place of iron rails. The prices ranged from \$174 per ton in March, 1868, down to \$95 per ton in January, 1872. In 1870, when it was proposed to place a duty of \$28 per ton on foreign rails, the Hon. S. S. Marshall, a prominent member of the House, made a strenuous protest, declaring that the duty would make the cost prohibitive. On the contrary, prices declined, but not for English rails. Four years after the duty was imposed, American rails sold at \$94.25 per ton, and a year later, when the Edgar Thomson plant was put in operation, a marked decline resulted, the average for the year being \$68.75 per ton. Rates were scaled down steadily thereafter as the manufacturers improved their facilities and reduced the cost, until the ephemeral boom between September, 1879, and February, 1880, when rails advanced from \$50 to \$85 per ton, the average for the two years, however, being about \$57. Since that time prices have declined steadily, the average for the last twenty years being about \$33, and since 1890, \$26 per ton.

From a production of 259,600 tons in 1875, when the Edgar Thomson plant started, the American mills reached an output of 2,270,000 tons in 1899. Great Britain rolled only 838,148 tons of rails that year, and not since 1879 has that country equalled the rail output of the United States. The Edgar Thomson works began with a production of about 50,000 tons for the first year and now has a capacity of 650,000 tons per annum. Three blast furnaces were added to the Edgar Thomson plant in 1880 and six others have been built since.



DUQUESNE FURNACE AND STEEL WORKS, DUQUESNE, PA.



HOMESTEAD STEEL WORKS, PITTSBURGH, PA.

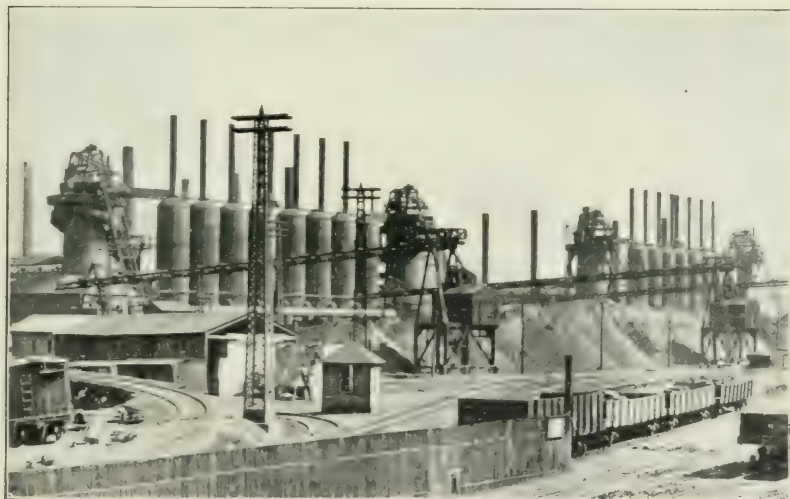


EDGAR THOMSON FURNACES AND STEEL WORKS, BESSEMER, PA.

THE GREAT CARNEGIE ESTABLISHMENTS.

This somewhat discursive bit of history is interesting in this connection as showing the growth of the most important branch of the American steel industry, in which Mr. Carnegie and the Edgar Thomson works have been the leading factors. For many years after the introduction of the Bessemer process in the United States (1864), the product was used in the manufacture of T rails almost exclusively, but gradually it supplanted puddled iron for structural purposes and the manufacture of rods, nails (1883), and other finished forms. The increased demand for Bessemer steel arising from this evolution was met, or in many cases anticipated, by Mr. Carnegie and his associates, and from time to time the works were enlarged or other steel plants and rolling mills purchased.

The Homestead steel works, built in 1880-1 by the Pittsburgh Bessemer Steel Company, and the Duquesne steel works, built in 1886-8, were thus acquired. Both plants had small Bessemer converters and rail trains originally, but the rolling of rails at Homestead was discon-



DUQUESNE BLAST FURNACES, CARNEGIE STEEL CO.

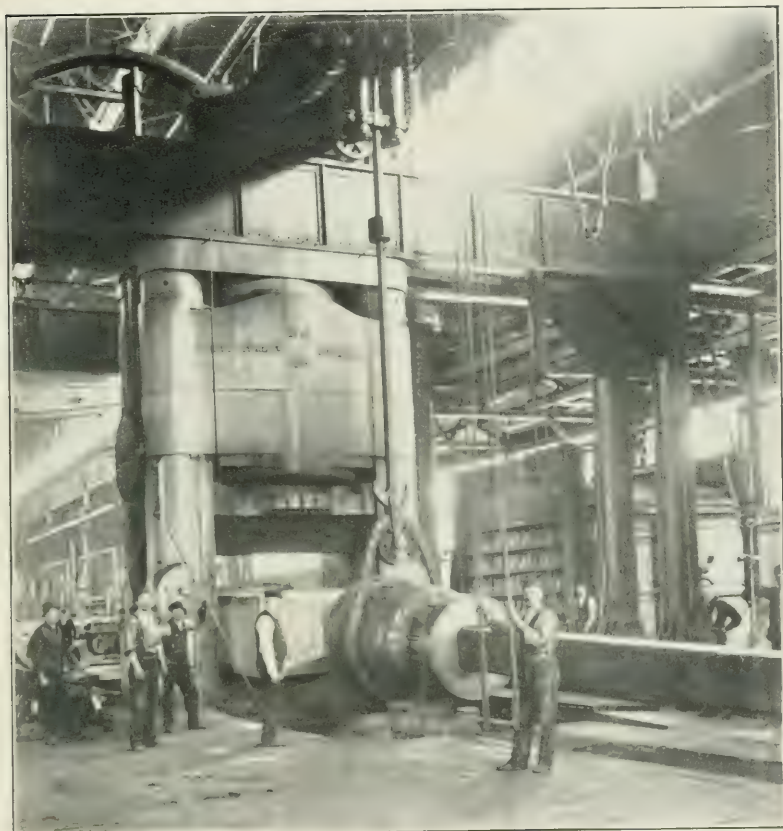
The four stacks have an aggregate capacity of 800,000 tons of iron per annum.

tinued in a short time, and at different periods subsequently other lines were taken up, including the open-hearth steel-making process, the rolling of steel structural shapes, ship and tank plate, and the forging of war-ship armor. The Duquesne plant has also been enlarged, and now includes four of the largest blast furnaces in operation, while an extensive plant for making open-hearth steel is under construction, in addition to several rolling mills.

The growth of the Homestead works has probably been more rapid than any like establishment in the world, and may be ascribed largely to the extended use in recent years of basic open-hearth steel. The first open-hearth plant, built at Homestead in 1886, comprised a small number of basic and acid furnaces. The acid process was after a thorough trial discarded entirely, and additional basic furnaces were constructed. The open-hearth-steel production of the whole United States in 1886 amounted to only 218,973 tons, as against 2,269,190 tons of Bessemer. Last year the Homestead works produced about 1,000,000 tons, or 34 per cent. of the open-hearth output of the United States, which was nearly equal to the total output of the entire country only five years ago.

This remarkable development, it may be observed *obiter*, is a significant sign of the times in the steel industry, denoting, as it does, the increasing preference for open-hearth over Bessemer steel in cases where the use of either is optional. For the last three years the production of Bessemer steel has increased 25 per cent. and of open-hearth 31.5 per cent. The introduction of the pressed-steel freight car partly accounts for this, but the increase of production is due primarily to the improvement in manufacturing practice and in the quality of product. It may be added that the open-hearth process will continue to gain on the Bessemer, and many believe that the latter is going slowly, step by step, the way of the puddling furnace; but the time for numbering its days of usefulness is still remote. However, the additions to productive capacity now building and projected in the United States are in the great majority of cases for open-hearth steel. In England the advance of the open-hearth furnace has been even more marked than in the United States. The change, it may be said, has been accelerated in that country largely by reason of the failing ore supply, with the consequent shortage of Bessemer iron, necessitating recourse to the open-hearth process, which uses scrap iron and steel, the supply of which is comparatively abundant. The Bessemer process lost first place in the British steel industry four years ago, the output last year being only 38 per cent. of the total steel product. Bessemer still holds first place in the United States, the output last year amounting to 72 per cent. of the total, which, however, is a loss of 10 per cent. in six years.

The Carnegie industrial system, which now embraces the mining and transportation of ore by rail and water and the manufacturing of coke, is the growth of years and represents the enterprise of the man who laid the foundation. In this respect it is unlike many contemp-



10,000-TON PRESS FORGING A 1-TON INGOT, HOMESTEAD STEEL WORKS.

reaneous organizations recently formed in the steel trade, comprising numerous small concerns originally competitive and created by many individuals.

The iron- and steel-manufacturing plants of the company now include 19 blast furnaces (2 building), 3 steel works with 8 Bessemer converters and 50 open-hearth furnaces (12 building), 5 rolling plants with 34 mills, an armor-plate works, and a forge for the manufacture of locomotive and car axles. These are all Cyclops worthy of the Homeric archetype. The works enumerated, with the improvements under way and completed, will have an aggregate capacity of 3,430,000 tons of steel per annum, equal to 32.56 per cent. of the production of the United States, 12.65 per cent. of the output of the world, and nearly 71 per cent. of the production of Great Britain, measured by the production for 1899.

In recent years extensive mines of rich iron ore have been added to the company's possessions in the Lake Superior region, and it now mines about 25 per cent. of the output of the district, which amounted last year to more than 4,000,000 tons. From the docks at the lake shipping ports the ore is carried in vessels owned or chartered by the company to Conneaut harbor, Lake Erie, where it is trans-shipped by rail 153 miles to the furnaces via the Pittsburg, Bessemer & Lake Erie Railroad.

The magnitude of the steel-manufacturing operations of the present day may be appreciated from the fact that during 1899 the receipts of raw material and shipments of finished product of the three largest Carnegie works aggregated 16,000,000 tons, which, according to Mr. J. T. Odell, equalled the combined tonnage handled last year by the Missouri Pacific, Southern Pacific, and Northern Pacific railways, operating 13,000 miles of track, 1,500 locomotives, and 50,000 cars. In the mining, transportation, and manufacturing operations the company provides employment for about 50,000 persons, and disburses yearly about \$50,000,000 to its operative and administrative forces. The business transacted is exceeded by few, if any, commercial organizations in America or Europe.

When the reason for the remarkable success of Mr. Carnegie and the business bearing his name is sought, it is easily perceived. Americans, and particularly those within the Pennsylvania coking-coal area and the iron-ore fields of Minnesota and Michigan, need only look around them for the principal cause. Mr. Carnegie simply availed himself of the natural riches indigenous to those favored regions, without which America would not be the leading producer of iron and steel in the world, or Pittsburg the *officina gentium*. As one well-informed writer observed a few years ago, the United States would still be in vassalage to Europe for many iron and steel products but for Lake Superior iron ore and Connellsville coke.

Andrew Carnegie, however, with the prescience which seems to be a common attribute of the Scot, saw or made the opportunities of the early days of the iron industry, grasped them by the forelock, and put his faith and capital into the business with invincible confidence. From the outset he held firmly to the conviction that the United States would in time surpass all other countries in iron and steel making, and he has never hesitated at any risk or sacrifice, however great, which promised to advance the industry. Having assisted in placing America in the lead of all the iron- and steel-manufacturing nations, Mr. Carnegie's single purpose has been to secure the position thus

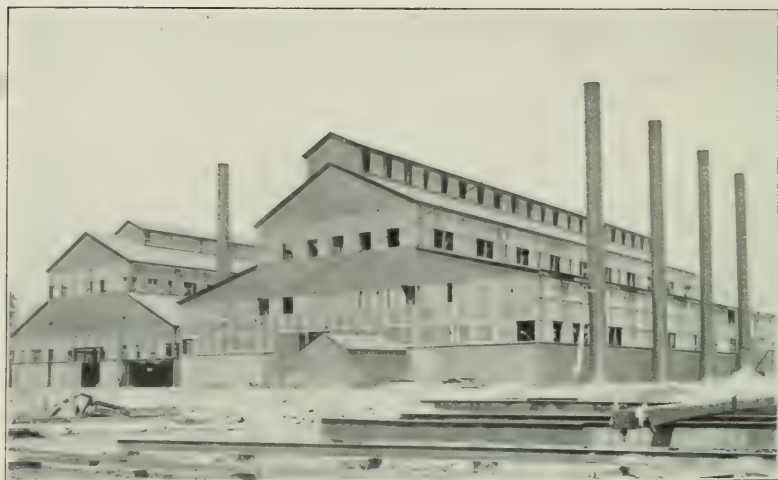


DOCKS OF THE CARNEGIE CO., CONNEAUT HARBOR, OHIO, ON LAKE ERIE, 155 MILES FROM PITTSBURG.

Nine ships can dock at the same time; 25,000 tons of freight can be handled in 10 hours; a 6,000-ton ship can be cleared in 14 hours, and in another 14 hours her cargo can be delivered to the furnaces in Pittsburg; a train of 35-40 ore cars can be loaded in two hours; a 40-ton car of coal can be loaded and partly trimmed in the ship in 36 seconds. On the left are vessels unloading to stock piles; the ship on the right is discharging directly into 50-ton steel cars.

attained by striving unceasingly for the most economical means in the utilization of the country's resources. Starting with the practice which the English preceptors gave with the fundamental iron and steel processes, imposing an everlasting obligation at the same time, America has, thanks to Mr. Carnegie, evolved a system in blast-furnace, Bessemer- and open-hearth-steel making, and rolling mill operations, essentially distinctive from the original, and conceded to be far in advance of the best European methods.

During this transition Mr. Carnegie has frequently been called upon to make large expenditures for new appliances to replace those which had been but recently adopted, and he has done this cheerfully, for with him the best is good enough only until something which promises a better and cheaper product is offered. He has willingly allowed the profits of the business to be taken year after year for experiment and improvement, whilst our friends across the water, content with the crude, anachronic system of by-gone times, took the



EXTERIOR OF HARVEIZING PLANT AND REAR END OF PRESS SHOP, HOMESTEAD.

This building was completed and running in 8 weeks from the time it was decided to build it. This record is an example of the energy characteristic of the Carnegie policy in carrying out any changes determined upon.

dividends and kept the even tenor of their way. The corollary of this reduced to figures shows that the United States in 1899 produced 39.25 per cent., Germany and Luxembourg 23.20 per cent., Great Britain 18.44 per cent., and the Carnegie works 10 per cent. of the steel output of the whole world, the Carnegie production being equal to more than one-half of the aggregate output of all the works of Great Britain.

For many years the traveller on the Pennsylvania railroad passing Braddock may have observed a broom of immense size towering far above one of the Edgar Thomson furnaces. This broom, as new methods of furnace working were introduced from time to time, was shifted from one stack to another, but it remained always with the Edgar Thomson group, signifying that the furnace over which it was raised had made a clean sweep of the furnace record of the world. The broom finally came down for good, but it was another, or rather several other Carnegie stacks which brought it down when the Duquesne furnaces were put in operation. The breaking of records since has been of such common occurrence that the broom was dispensed with, as the necessity for shifting became too frequent and troublesome.

The capacity of the blast furnace since the first Lucy stack was built in 1872 has been increased from less than 100 to more than 600 tons per day, and two others will shortly be blown in which will produce 700 tons each per day. The development of the blast furnace is

fairly indicative of the progressive march in every branch of iron and steel making as carried on by The Carnegie Company, from the mining of the ore and coal through the entire scale of operations to the final handling of the finished steel. During the 30 years Mr. Carnegie has been identified with the industry, the works under his control have fabricated over 50,000,000 tons of iron and steel for the multifarious uses of civilization, making possible the construction of many miles of railroad that could not have been built had he not been the actuating force in revolutionizing manufacturing and competitive conditions.

Mr. Carnegie has been not only the architect of his own fortune, but has opened the door to opportunity and wealth for many men, sharing his success at all times with his employees and business associates with unexampled liberality. He has made many young employees partners in the business for meritorious service, assigning to them, virtually without the payment of a penny, valuable stock interests, requiring payment only from the profits of the shares, that they might not consider such transfers as gifts but as their due. The first charge on the revenues of the business is for the best-paid labor in the world, and Mr. Carnegie makes it a paramount obligation to maintain that standard and to provide steady employment for the thousands whose welfare is in his keeping.



STORAGE YARDS, HOMESTEAD WORKS, WITH ELECTRICAL APPLIANCES FOR HANDLING BEAMS.

Exemplifying the promptness in applying every agency affording increased convenience or economy in manufacturing operations.



CASTING A 90-TON INGOT. SHOWING THE 150-TON CRANE FOR HANDLING INGOTS AND LADLE, HOMESTEAD STEEL WORKS.

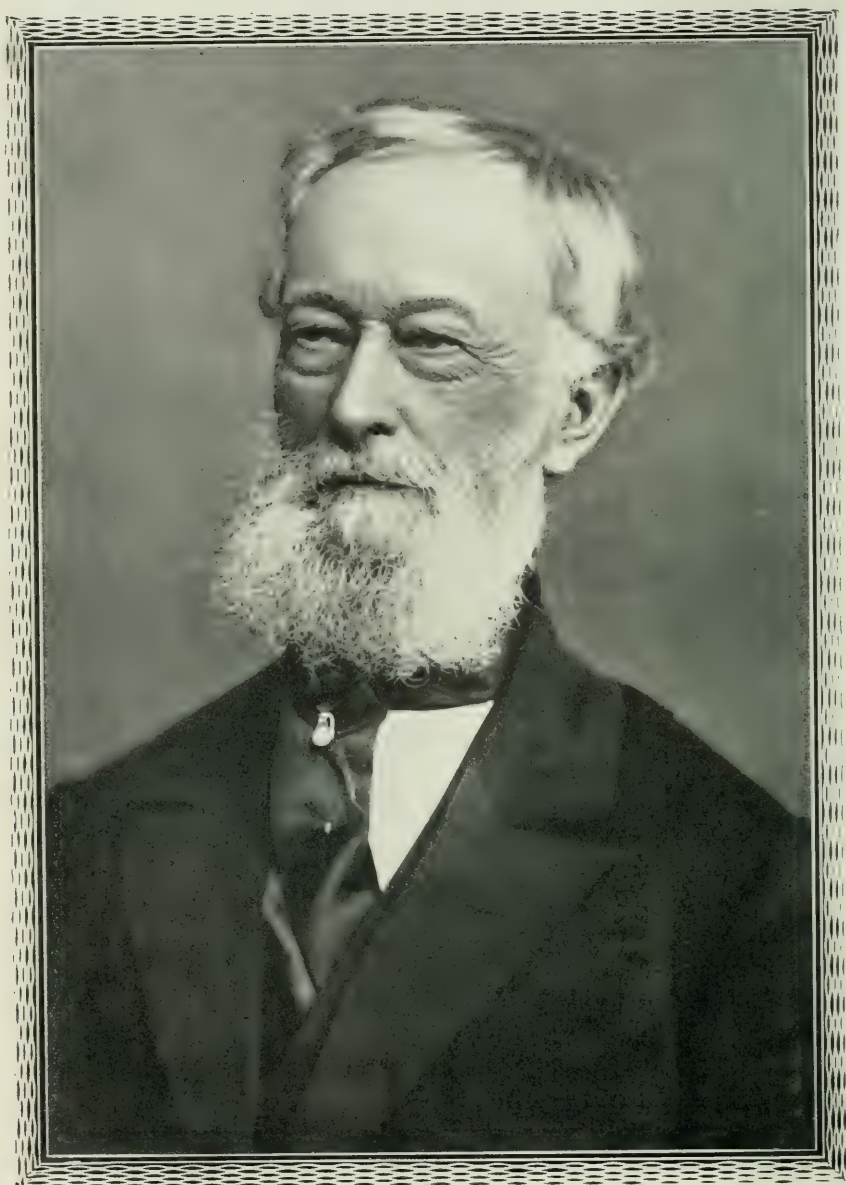
The public philanthropies to which he has devoted millions aim to be practical and are characteristic of their creator, but perhaps the most wisely conceived benefaction of the many he has originated was instituted some years ago for the employees of the steel company. The cardinal canon of his famous "Gospel of Wealth" and the governing motive in all his philanthropic efforts is to help those who try to help themselves. This doctrine was put into practice first when he established a savings and loan fund for the employees, and put a premium on thrift and economy by obligating the company to pay everyone who deposited his savings with the company a higher rate of interest than could be obtained from any public savings institution. The com-

pany has done this ever since, paying a fixed rate of 6 per cent. annually, regardless of business conditions, deficits in interest earnings, or the fluctuation of savings-bank rates, and, in consequence, the fund now has a larger number of depositors with a higher average of deposits than any of the public savings institutions in the mill localities.

For the purpose of enabling the workmen to acquire their own homes, loans are also made from this fund on more liberal terms than can be obtained otherwise, and many of the workmen own comfortable dwellings secured by the assistance thus given. Every department foreman and paymaster in the various works is authorized to receive deposits, and the many chances afforded the workman by this arrangement to put by surplus earnings to his credit with the company before he leaves the works on pay day, have been an effective means of helping him not to squander his money, for the temptations to spend freely and foolishly which beset the average workman before he reaches his family with his earnings are many, and to a large number, irresistible. The company, in addition to guaranteeing the high interest rate, which is about double the amount allowed by banks, assumes responsibility for the entire running expenses of the fund, giving the services of the accountants and clerks needed to transact the business without charge upon the depositors.

While Mr. Carnegie has done much and promises to do more to enrich the race by giving millions to foster what he considers the best adjunct to the public school in the advancement of popular education—the free public library—yet he counts the satisfaction of distributing his wealth as naught compared with the pleasure he has given others in the making of it; for he believes with the philosopher that the highest reward of life's labor is the enjoyment of seeing others benefit by it. That he has been able for so many years to provide the means of livelihood for thousands with good wages and steady employment, helping at the same time to cheapen and extend the use of the principal manufactured product of the country, is to Mr. Carnegie far more reason for gratification than the realization of his best-laid plans for disposing of the income.





ALFRED KRUPP.

Who Chiefly Built up the Vast Krupp Works.

THE FOUNDERS OF THE KRUPP ESTABLISHMENTS.

By E. Schrödter.



OWING to the Thirty Years War and the severe conflict through which Germany passed in the eighteenth and early part of the nineteenth centuries, the fair and powerful empire, in which trade and industry had flourished and great prosperity had reigned, was transformed into a feeble, dis-united conglomeration of states, in which habitations were burned down and misery, wretchedness and poverty everywhere prevailed. The iron industry, which, during the middle ages, had reached a state of prosperity in Silesia, in Thuringia, in the Harz, in the Sieg valley and on the Rhine, was also affected by the general depression. In a few spots only were small iron works able to maintain a precarious existence.

Even when, about the beginning of the nineteenth century, the puddling furnace was invented and it had been learned how to use mineral coal in place of the hitherto universally employed charcoal, the financial means were lacking to make use of these new discoveries; and so it happened that while in Great Britain, which was protected by its insular position from the disturbing influences of war, the manufacture of iron received a powerful impetus in the early part of the century, Germany's iron industry was able to take but a very small part in the new developments. It was only about the middle of the century that the real advance in Germany began—slowly at first, but moving with accelerating speed after the establishment of the new empire by Kaiser William I. and Prince Bismarck in 1871. Among the

The Krupp establishments, unlike the other three treated in this group, represent the creative effort of a family rather than that of an individual—the result of persistent purpose and transmitted genius through three generations. Like the Carnegie works, they rose with the tremendous growth of the iron trade; they are associated with the expansion of German military power as Elswick is with the rise of the navy; they parallel the Westinghouse ideals in illustrating the success following the patient, painstaking, thorough development of a mechanical idea, coupled with the commercial ability needed to present it in the market. Like all the huge enterprises whose annals are briefly written here, they display that aspect of genius which has been briefly summed up as “an infinite capacity for hard work.”—THE EDITORS.

establishments which, in the course of the century, have developed from small beginnings into great centers of industry, the cast-steel works of Frederick Krupp stands in the front rank.

Frederick Krupp, the grandfather of the present proprietor, descended from a prominent Essen family, established a small forge there in the year 1810. In 1812, the same year in which his son Alfred



KRUPP'S ANCESTRAL HOUSE.

"Fifty years ago, this dwelling, originally a labourer's, was the refuge of my parents. May all our workmen be spared the care and anxiety which the founding of our establishment cost. For twenty-five years the outcome was in doubt, and only after much effort and perseverance have the labours of the past been so wonderfully rewarded.

"May this example encourage others in affliction; may it increase respect for small abodes and sympathy for the great cares so often felt therein. 'The end of labour should be the common weal; then labour brings blessing, then is labour a prayer.'"—*Alfred Krupp, Essen, 1873.*

was born, he offered to the public some cast steel which he had himself made. The manufacture of this material had up to that time been understood only by the English, particularly by Huntsman, of Sheffield, but they were unable to send their product to Germany on account of the closure of the Continental ports by Napoleon's decrees.

With the profits derived from his forge, Frederick Krupp was enabled, in 1818, to build a small plant, consisting of eight melting furnaces, with one crucible apiece, on the spot where the great, world-famed establishment now stands. Although the good quality of his product was recognised, he had not attained complete success at the time of his death in 1826. The cast-steel works were carried on by his

widow and his eldest son, Alfred. The fourteen-year-old boy, who was obliged to leave school, laboured untiringly at the crucibles, assisted by two workmen. While engaged in this hard toil, often lasting through the night, he lived on potatoes, coffee, and bread and butter, without any meat. He was master and apprentice, he was founder and smith, packer and errand-boy, bookkeeper and travelling man. On Sundays he wrote up the books and made out the accounts.

The two workmen were gradually increased to five, and by 1832 there were ten, besides Alfred's younger brothers, who now assisted him. One of the first successes of the young establishment was the preparation of mint dies, and after Krupp had invented a special roll for the manufacture of spoons, orders flowed in so rapidly that in 1842 he was able to employ 100 workmen. In 1843 he forged the first gun-barrels with his own hand, but he did not have success with them. In 1847, the year of famine and political disturbances, the number of workmen fell from 188 to 72, and Krupp hazarded his last penny to continue the payment of wages.

About the middle of the century the railway era began, which made heavy demands upon the iron industry. Krupp took a leading part in supplying this demand, and distinguished himself by the invention of the seamless wheel-tire, which he made by taking a round cast plate, making a conical hole in it, and then driving mandrils of increasing diameter through the opening until the desired size was attained.

At the first international exposition, the London World's Fair, in 1851, Krupp exhibited a cast-steel ingot of 45 hundred-weight and a six-pounder cannon, also of cast steel, for which he received the highest award. At Paris, in 1855, his exhibit contained a cast-steel ingot of 100 hundred-weight and a twelve-pounder. At last he received the first order for artillery from the Prussian government, and the goal toward which he had struggled for many years was reached. Krupp cannon soon had an opportunity to prove their metal in actual warfare, as at the terrific bombardment of Missunde in 1864, and in the battle of Königgrätz in 1866. As a result heavy orders came in, not only from Prussia, but also from Russia, Italy, Turkey, and other states. The establishment was, in consequence, continually enlarged, iron and coal mines were bought, and new inventions were introduced. About this time Krupp left his old dwelling, which stood in the midst of the works, and built a country villa at Bredeney, about three miles away, which in the course of time has developed into a princely residence. The year 1867 brought Krupp new fame through the exhibit of a steel ingot weighing 40,000 kilogrammes (88,000 pounds), and a

giant cannon of 14 inches internal diameter and with a length of 21 feet. In 1868, at a shooting trial at Tegel, he drove the Armstrong cannon from the field. In 1870, 2,000 Krupp cannons forced Sedan to capitulate. At Vienna, in 1873, and at Philadelphia, in 1876, he astonished the world with new and wonderful works. Emperors and kings visited the cannon king, who was loaded with worldly honours.

On July 14, 1887, he departed this life, bequeathing his vast properties to his only son, Frederick Alfred Krupp, who had qualified himself for the succession by toiling early and late in the works. The new proprietor was not only able to fulfil the difficult task of conserving the existing establishment, but he also enlarged the work in all directions and added new branches, so that at present more than twice as many workmen are employed as there were at his succession less than fourteen years ago.

The establishment to-day consists of the cast-steel works at Essen; the Krupp steel works, formerly F. Asthöwer & Co., in Annen, Westphalia, where steel castings of all kinds are the principal product; the Gruson works at Buckau, near Magdeburg, where hardened cast armour, armoured turrets, crushing machines, and so on, are made; four blast-furnace plants, at Rheinhausen, Duisburg, Neuwied and Engers; four coal mines in various parts of the Empire, namely, the Hannover mine, shafts Nos. 1 and 2; the Hannover mine, shafts Nos. 3 and 4; the Sälzer and Neuack mine, and the Hannibal mine; part interests in other coal mines; a great number of iron mines in Germany and several iron mines in Spain; a proving ground at Meppen, 16.8 kilometers (10.5 miles) in length, with provision for extending the firing range to 24 kilometres (15 miles); three ocean steamers; several stone quarries; clay and sand pits, etc., etc. Besides all this, the firm of Fried. Krupp operates, by contract, the Germania Ship- and Engine-Building Company, of Berlin and Kiel. At the latter yard far-reaching enlargements are in progress, as is also the case at the parent works in Essen, where many large new buildings are being erected in order to satisfy the increasing demands made upon the melting furnaces, the armour-plate factory, and the cannon works. The new blast-furnace plant at Rheinhausen, opposite Ruhrort, consists of three furnaces, 23 meters (75 feet) in height, each with a daily capacity of 230 tons. It is purposed to add a basic-steel works to this plant before long, while at Essen only acid converters will be operated. According to figures taken in October, 1900, the above enumerated works employed not less than 46,700 persons, including 3,733 officials.

As sole owner, Herr Krupp has the general management of the



F. A. KRUPP.

The Present Representative of the Family.

gigantic works at Essen and its branches, but he has transferred to a board of twelve directors the most comprehensive powers for conducting the business. The whole establishment is divided into about one hundred departments and offices, each of which is managed by a single head, with the help of assistants. According to their kind, related groups are combined to form sections, at the head of each of which is a responsible chief. The various auxiliary departments, such as the gas- and water-works, the laboratories, and the fire department, to which alone 95 men belong, are under the direct control of this "Direktorium."

The oldest specialty of the cast-steel works is the production of crucible steel; that is, of steel which is made by the melting together of specially-prepared iron and steel in closed crucibles, from which the metal is cast into ingots, the largest of these attaining a weight of 85,000 kilogrammes (187,000 pounds). For casting such an ingot more than 2,000 crucibles are required, and it takes hundreds of foundry-men, working in military order, to collect the molten metal into one mould. The highest quality of raw material is used in the production of crucible steel, and, starting with the ore, all the processes are carried on in the firm's own establishment. This steel is distinguished for the great purity of its material, and the ingots cast from it—even to the heaviest ones—are entirely homogeneous, solid, and uniform—a result which cannot be attained so certainly by any other process.

Crucible steel is therefore employed at the works in the manufacture of all products in which high reliability is of the first importance; it is thus used, above all, for cannon tubes, gun barrels, and armour-piercing shells, as well as for the more important parts of locomotives, stationary engines, marine engines, hoisting engines, and for large rolls for iron plates and armour plates. It is also used for parts in which the least possible amount of abrasion is to be combined with great security against fracture, as in wheel tires and axles of locomotives, tenders, and cars, for tools and springs, for gold and silver rolls, mint rolls, mint dies, etc.

The Martin steel made at the cast-steel works is used, in general, for purposes similar to those for which crucible steel is employed, with the exception of cannon tubes, which are made exclusively of crucible steel. Martin steel is also largely used in ship-building, for plates and angles, for armouring war-vessels, for projectiles, for parts of gun carriages, for boiler plates, for railway-car axles and wheel tires, for springs, wire, and so on.

The manufacture of steel castings out of crucible and Martin steel

is carried on very extensively at Essen. Castings are made for railway material, such as points and switches, for wheels for locomotives and cars—the manufacture of cast wheel centers and web-wheels being a specialty of the works—for machine parts, for parts of ships, such as stems and stern-posts, rudders and screw-propellers, for construction work, and for various other purposes. The castings are made of the most complicated forms and in weights running up to more than 60 tons, this being another specialty of the Essen establishment.

A particular branch of manufacture is the production of puddled steel. The greater part of this is used at the works as raw material for crucible steel, but it is also shipped outside for special purposes, such as the manufacture of wheel tires for artillery carriages in heavy service, and it has a large sale, under the name of “milano” or “bamboo-steel,” in transmarine countries, where it is used for tools.



CASTING CRUCIBLE STEEL AT THE KRUPP WORKS.

The Bessemer steel produced at the cast-steel works is used principally on the permanent way of railroads for rails, fish-plates, base-plates, and so on.

Besides the kinds of steel already mentioned, there are prepared various alloys of steel with tungsten, nickel, chromium, molybdenum, etc., which are used for special purposes.

The Krupp firm has gained its universal reputation by the manufacture of cast-steel cannon, of which there had been delivered not less than 38,478 pieces up to the end of 1899. These comprise ship's guns and coast-defence cannon, with calibres from 3.7 to 42 centimeters (1.45 to 17.5 inches), siege guns, cannon for fortifications, field and mountain artillery—including rapid-fire field and mountain guns—all in complete batteries, with equipment and ammunition, ammunition carts and supply waggons, and army vehicles for every purpose.

The Krupp firm has made the double-wedge breech block, which was introduced in Prussia in 1861, a particular factor in the development of its business. In 1865, Krupp introduced the single wedge, with semi-cylindrical rear surface, called round wedge for short, which is the fundamental form of all Krupp wedge breech-blocks. Compared with the screw breech-block, the wedge block has certain advantages and disadvantages, but the experience of the firm seems to show that the former preponderate. This opinion may be strengthened by the circumstance that France, the home of the screw block, in selecting a new rapid-fire field gun, has chosen not the screw block, but, according to all appearances, the Nordenfelt breech mechanism with eccentric screw, which is a breech-block whose mode of operation is essentially that of the wedge block.

Hand-in-hand with the making of cannon goes the manufacture of steel armour, "semi-armour," percussion shells, armour-piercing shells, steel bomb-shells, steel shrapnel, cast-iron shells with fuses, cartridges, fuses and fuse mechanisms, and gun barrels.

For the manufacture of armour plate there is a great rolling mill and a 5,000-ton hydraulic press. Armour-plate manufacture has gone through five stages. The first plates were made of wrought iron. In 1873, C. Cammell & Co. invented the compound plate, which was prepared by pouring liquid steel onto hot iron plates. Then Schneider, of Creusot, demonstrated that steel plates were preferable. These were further improved by alloying the steel with nickel; and, more recently, by the process, invented by the American, Harvey, of face-hardening the plates by causing the outer layers of metal to take up a greater percentage of carbon. As is well known, the Krupp firm has discovered a new process, that is kept secret, for hardening steel plates as well as nickel-steel plates, by which a product of unexcelled quality is turned out. The principal armour-plate makers of America, England, and France are now using this process, under agreement with Krupp.

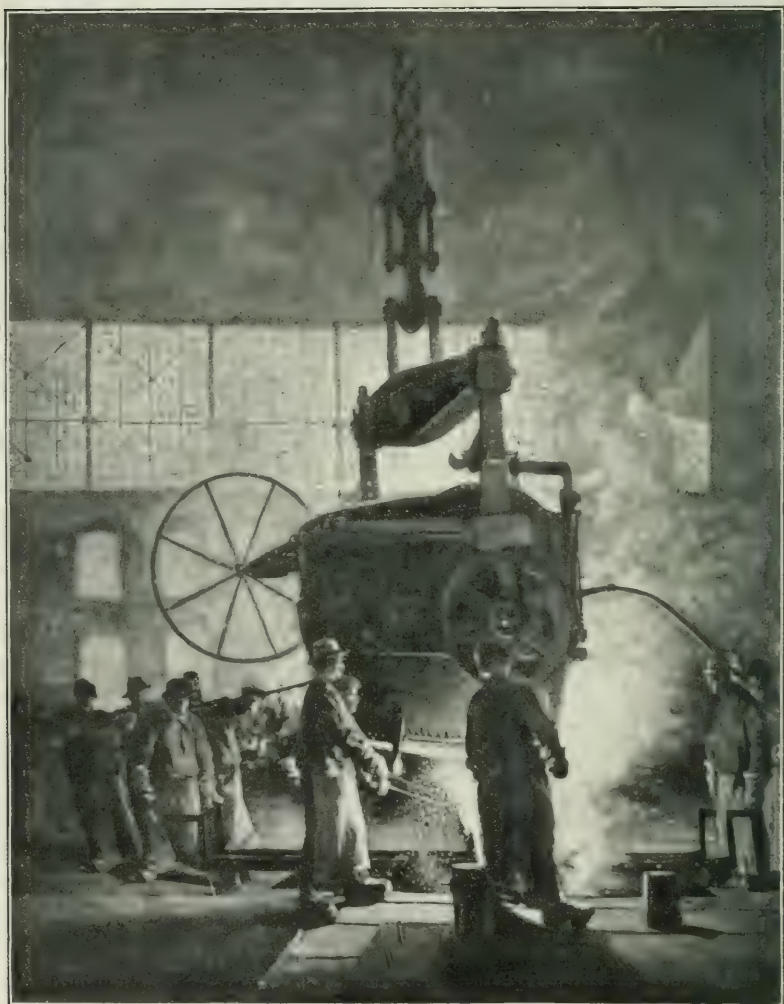
At the beginning of 1900, the real estate belonging to the Krupp firm in Essen and the surrounding communities, not including the dis-

trict of H $\ddot{u}$ gel, amounted to about 360 hectares (890 acres), of which 62 hectares (153 acres), were covered by buildings. At the various Krupp iron mines there has been for the past few years an average daily output of ore amounting to about 1,877 tons. The firm's coal mines have produced about 3,738 tons a day, on an average, but the coal consumption in all branches of the business averaged 5,000 tons a day, or over 1½ million tons per annum. About 115,000 kilogrammes (253,000 pounds) of refractory brick and stone, and from 2,000 to 2,500 melting crucibles are made and used every day. The

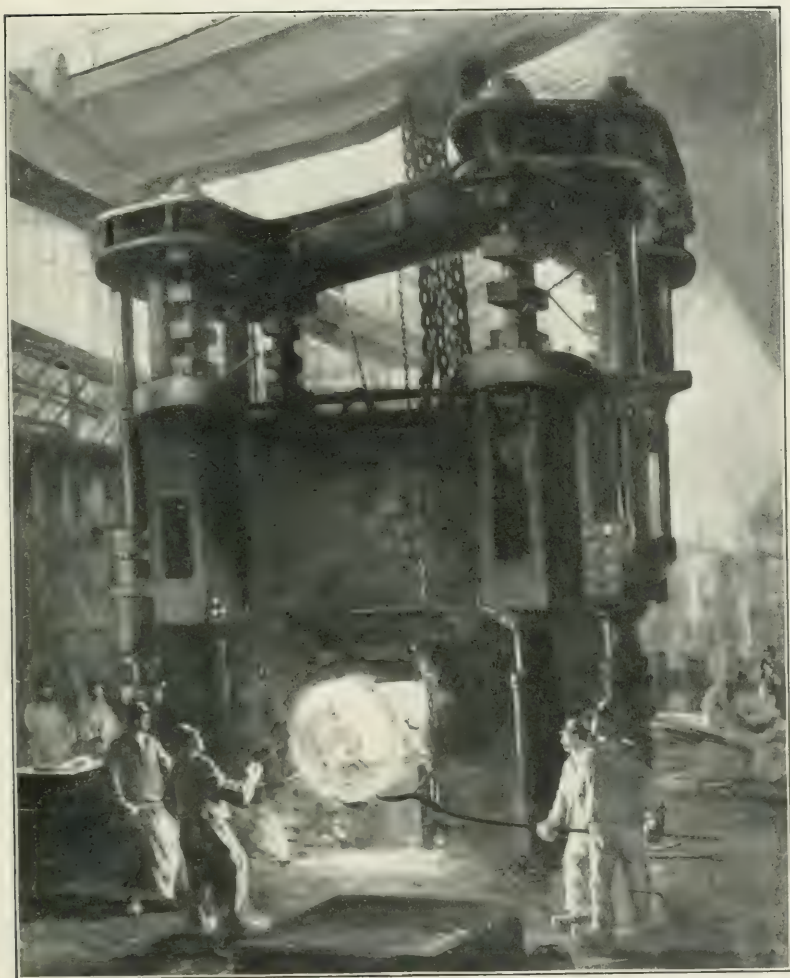


KRUPP ARMOUR-PLATE ROLLING MILL.

water consumption of the cast-steel works at Essen alone amounts to over 15 million cubic meters (530 million cubic feet) per annum, or as much as that of a city of 400,000 inhabitants. There are 171.59 kilometers (107 miles) of water pipe underground, and 106.48 kilometers (66 miles) inside the buildings. The annual consumption of illuminating gas is nearly 19 million cubic meters (670 million cubic feet), and the Krupp gas works, according to production, ranks seventh in the German Empire. Electric current is generated in three



CASTING OPEN-HEARTH STEEL AT ESSEN.



THE 5,000-TON HYDRAULIC FORGING PRESS

engine rooms and six distributing stations, and feeds 877 arc lamps, 6,724 incandescent lamps, and 170 motors.

Transportation at the cast-steel works is provided for by a standard-gauge railway system with 58 kilometers (36 miles) of track, 16 locomotives with tenders, and 707 cars, and also by a narrow-gauge system with 44 kilometers (27 miles) of track, 26 locomotives, and 1,209 cars. Cars arrive at and depart from three stations where there are fifty trains daily.

In the testing plant of the cast-steel works at Essen, as well as in those of the plate rolling-mill, the rail mill, and the gun-carriage shop,

there were made altogether in 1899 173,209 resistance tests of materials, of which 87,626 were breaking tests and 83,262 bending tests. In the same year, 26,240 analyses were made in the chemical laboratory of the cast-steel works.

Although the German government provides in a comprehensive way for sick, old, and injured workmen by means of sick funds and old-age and invalid insurance, and the trades associations also help in this benevolent work, yet the Krupp firm has instituted a great number of philanthropic enterprises which go far beyond the boundaries of the legal requirements.

During 1899, the firm paid out 1,103,619 marks (\$262,767) on account of the sick-insurance, the mining, the accident-insurance and the old-age and invalid-insurance laws, and 1,095,973 marks (\$261,422) in other statutory contributions. Besides this there were a number of extraordinary payments, some of them very considerable, which it is not possible to enumerate in this place.

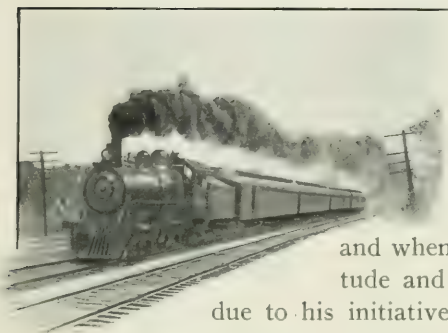
In 1853 Alfred Krupp established a fund for assistance in case of sickness and death, which, after legal provision was made for sick-funds, had its scope enlarged. A pension fund, independent of government requirements, assures to every Krupp workman, in case of disability after 15 or 20 years' service, a retired pay amounting to 40 per cent. of his wages, which percentage is increased after longer service. The pension fund, with assets of 5,000,000 marks, pays out 500,000 marks annually in this manner. A life-insurance society was also founded by Alfred Krupp, with a liberal donation. The Colony of Altenhof is intended exclusively for old and disabled faithful employees.

Up to April 1, 1900, Friedrich Krupp had erected 4,853 family dwellings, in several colonies, to which must be added several hospitals, casinos, libraries, schools, and other buildings. There is also a large store, in which, at 47 counters, provisions and useful articles are sold to employees of the firm at low prices. Besides this, the firm has its own slaughter houses, bakeries, tailor shops, shoe shops, a hotel, and several beer halls and coffee rooms.

One may cast a glance into the modest room of a workman's dwelling, or gaze in wonder at the casting of a mighty ingot of crucible steel; one may spend an hour at the house-keeping school, or follow the flight of a 24-centimeter shell, but everywhere one perceives the touch of a great genius, whose spirit animates this gigantic creation in all its details, holds it together, and enables it to perform works which excite our amazement and admiration.

GEORGE WESTINGHOUSE—INVENTOR, ORGANIZER, AND DIRECTOR

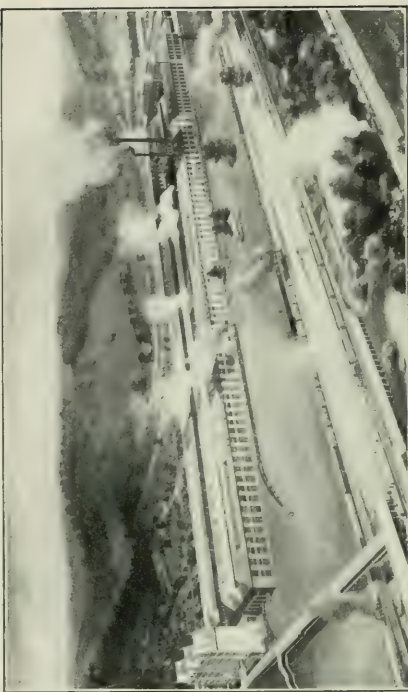
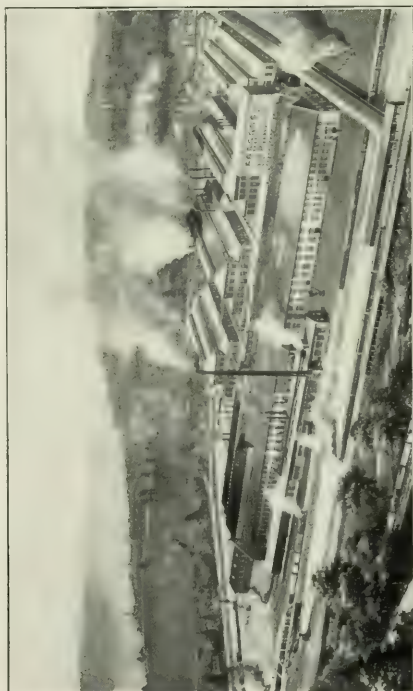
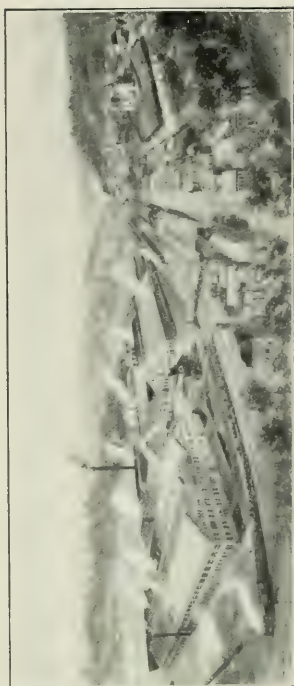
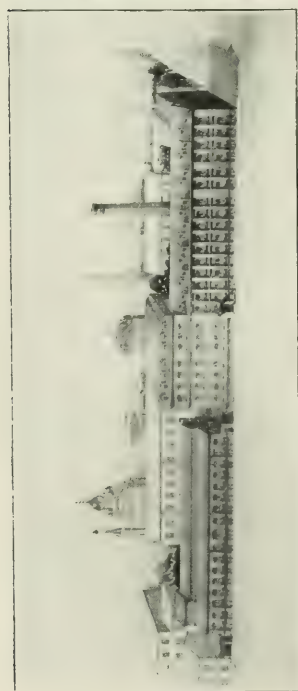
By Walter M. McFarland.



WHEN a number of great manufacturing establishments, covering several important industries, bear the name of one man, there is a natural desire to know something about him; and when it is understood that the magnitude and success of these enterprises are due to his initiative and guiding hand, the interest becomes much greater. There is a feeling on the part of almost everyone that if we could but understand his character and life we might perhaps discover the antecedents to success; and to those who realize that there are younger men coming on who must some day take the place of these leaders, there comes the thought that the life of such a one may be an inspiration and help to some worthy successor. There has probably never been in the history of industry a life which will better repay careful study than that of the subject of this sketch, Mr. George Westinghouse, whose name is undoubtedly as widely-known as that of any engineer or inventor who has ever lived, for his most famous product—the air brake—has gone wherever the advance of civilization has carried the railroad.

It may be well at the start to correct an impression, which seems to prevail to some extent, that Mr. Westinghouse is an old man. This is doubtless due to the fact that the air brake has been widely used for so many years; as a matter of fact, he is still a young man, having been born in 1846. He comes by his engineering ability naturally, as his father was a manufacturer before him, and the old works under the name of "George Westinghouse & Company" are

The genius of George Westinghouse is of the type generally distinguished as characteristically American—the combination of the skill and ingenuity of the inventor with the highest form of managerial and commercial ability. Mr. McFarland shows impressively how large a part in his success has been played by boundless capacity for hard and unrelenting work, supplementing the other two great factors—first, the contribution of some great improvement to the economy of engineering, and, second, the faculty of organization in its production. On this triple foundation—inventiveness, organization, energy—the structure of successful manufacturing is securely raised.—THE EDITORS.



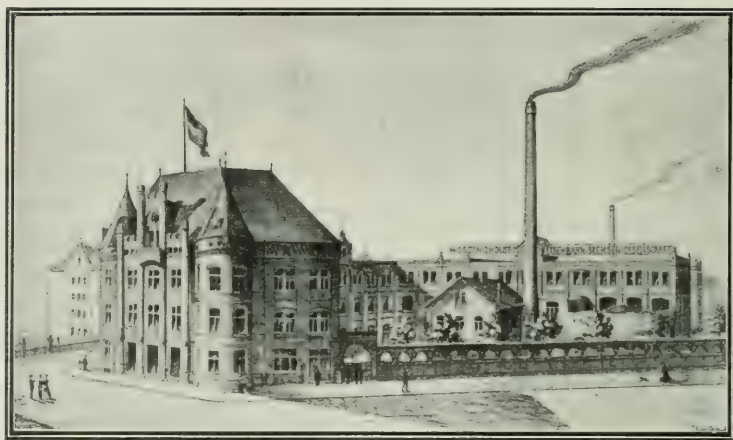
SOME OF THE PRINCIPAL WESTINGHOUSE ESTABLISHMENTS.

Westinghouse Air-Brake Works, Wilmerding, Pa. U. S. A.
Westinghouse Machine Co.'s Works, East Pittsburgh, U. S. A.

Westinghouse Air-Brake Works, St. Petersburg, Russia.
Westinghouse Electric & Mfg. Co., East Pittsburgh, U. S. A.

still in existence at Schenectady. He displayed a strong mechanical aptitude at an early age, and had become familiar with tools and skilled in their use when the United States civil war broke out. Although still only a boy, he took his part in the struggle to preserve the Union, and served for more than a year in the army, first in the infantry and afterwards in the cavalry. Realizing, however, that his mechanical aptitude would enable him to render more valuable service in the navy, he became an engineer officer and served until shortly after the close of the war, when he resigned. It may be said, in passing, that the engineer corps of the navy has always felt proud that it numbered at one time among its members an engineer of such distinguished ability and one who has done such splendid work.

After leaving the navy Mr. Westinghouse returned to his home in Schenectady, where Union College is located, and for a time was a student in that institution; but feeling the desire for active engineering work, he did not complete the regular college course, but devoted himself to the practice of engineering. He developed a special railroad frog which was a success, and was engaged in its exploitation when his attention was called to the deficiency of the brake apparatus on railroad trains. The invention of the successful brake was an evolution from the crude methods then in vogue, which were, in effect, the application, on a larger scale, of the familiar wagon brake. He soon saw that there must be a motor cylinder under each car, and the natural impulse was to use steam. The difficulty from condensation, however, negatived this method. While studying this problem, his close touch with engineering progress made him aware of the successful transmission of power by means of compressed air in the boring of the Mont Cenis tunnel, and it occurred to him that here was an efficient means of applying power to the motor cylinders of the brakes on railway trains. Mr. Westinghouse is not one of the dreamy inventors of whom the world thinks as waiting for an inspiration to come full-fledged, like Minerva from the head of Jove, but with him to have an idea is to begin to work it up in thorough engineering fashion, with the added ability to make any machine with his own hands. Constant study, experiment, and hard work enabled him to develop the necessary details of the air brake, and then came the question of giving it an actual working trial. In connection with the introduction of the air brake we see some of the characteristics which have contributed to his success, viz., his business acumen and the determination to subject his inventions to an actual working trial before putting them on the market. To make the trials on a large scale meant the ex-



WESTINGHOUSE BRAKE WORKS, HANNOVER, GERMANY

penditure of a large amount of money, and Mr. Westinghouse himself was not possessed of sufficient means at that time. He, therefore, associated with him a capitalist who had the necessary means, and after great effort and much discouragement found a progressive railroad man, who, after studying the brake, had sufficient faith in it to place at his disposal a train upon which to experiment. It is very pleasant to add that this gentleman, upon whom Mr. Westinghouse justly looks as one of his best friends, has been associated with him for many years in the Air-Brake Company. The brake had been worked out so thoroughly that it was a success from the start, and, indeed, on the very first occasion when it was used it resulted in the prevention of a serious accident. From that time its introduction went on rapidly, and it would soon have been difficult to find any road whose passenger trains were not fitted with Westinghouse brakes.

After the successful introduction of the air brake in the United States, Mr. Westinghouse went abroad to secure its introduction in Europe, and here again his mechanical skill, business ability, tact, and attractive personality led to its gradual introduction and the practical supplanting of all other brakes. The case here was not quite the same as it had been in America, for the success in the latter country had led to inventions suggested by his, but on somewhat different lines, in order to evade his patents. These, however, were never the success that the Westinghouse brake was from the start; indeed, the history of the Westinghouse brake and its rivals, as printed in the technical papers, was the best advertising that could have been secured.

While discussing this phase of his activity, and to make it com-

plete, it may be said, as showing other qualities of his character, that he was always seeking to improve the brake, and his invention of what is called the "triple valve" was so great an improvement as almost to equal the invention of the brake itself. As is well known, this enables the brakes to be applied almost instantaneously on a train of as many as sixty cars, and it also led to the great advantage that if a car breaks away from the train the brakes are instantly set—a fact which has prevented many an accident. A mere inventor would have been satisfied with the success and perfection of his mechanism, but Mr. Westinghouse is much more than an inventor: he is a shrewd business man and an organizer of the very first rank. Consequently when the use of the brake had developed, his next care was to organize its manufacture so as to produce the apparatus cheaply and in large quantities. The air-brake works at Wilmerding, Pa., constitute a factory which is probably as nearly perfect as one can be made. A visit to these works is a perfect treat to an engineer, who sees the differentiation and specialization of manufacture combined with the utmost accuracy and highest finish, where these are necessary or desirable, and the whole so arranged that, while the workmen receive high wages, the product is so cheap that it was found by actual trial on the part of one railroad that it was cheaper to buy the brakes from

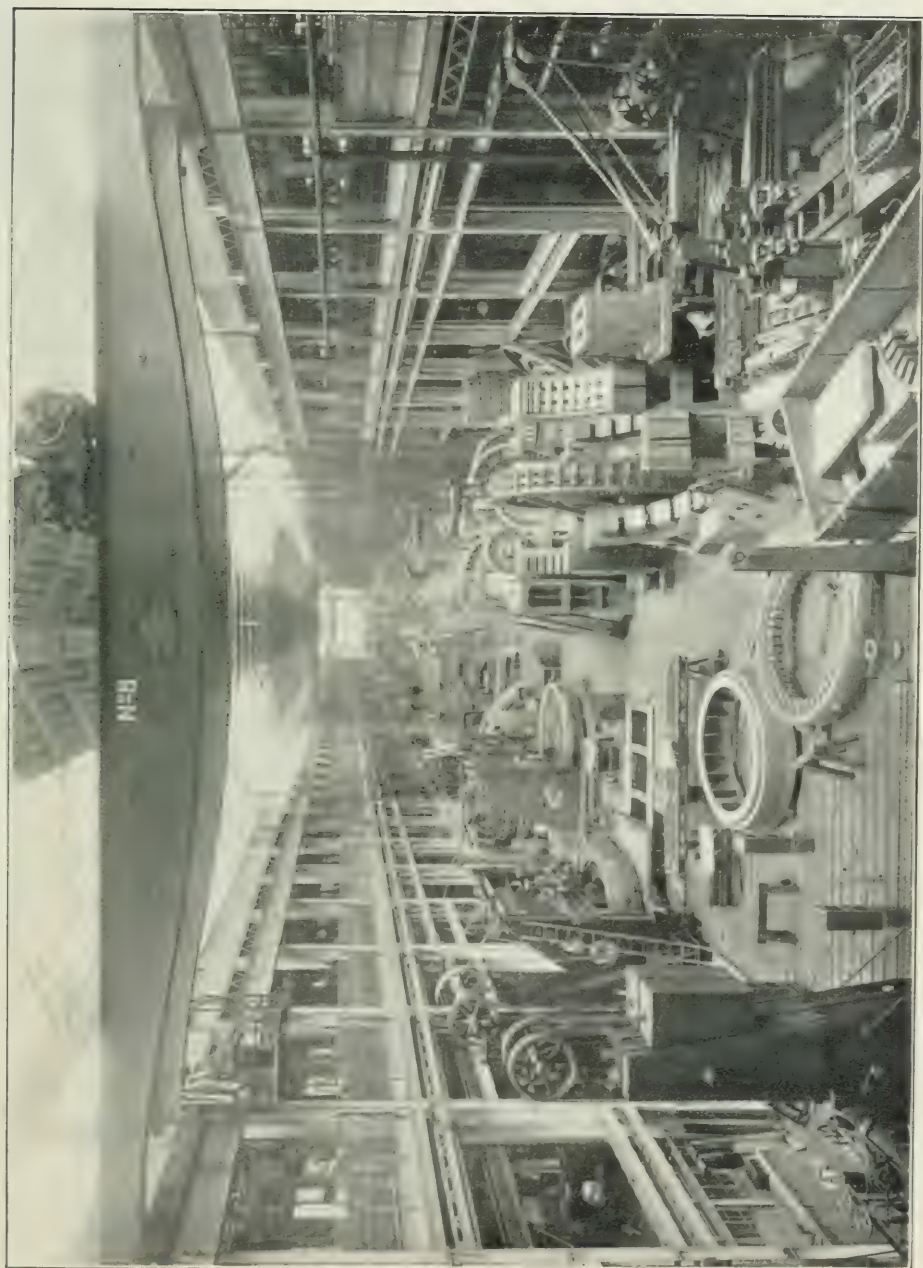


LATHE DEPARTMENT, WESTINGHOUSE AIR-BRAKE WORKS, WILMERDING, PA. U. S. A.

Wilmerding than to manufacture them upon a very small royalty. In all this development Mr. Westinghouse has taken a most active part, and it is his own work in every respect. When he planned the works at Wilmerding he made them about twice the size that any of his friends and advisers believed to be necessary, but the accuracy of his foresight has been fully justified by events which have shown that he estimated the future demand much more fully than did his contemporaries. This foresight and courage are characteristics of Mr. Westinghouse which impress themselves most strongly upon those who are permitted to know his plans.

It was through his connection with railroading that Mr. Westinghouse became interested in electrical development by way of the pneumatic devices for switching and signaling, which are controlled electrically. Having already made such a successful application of pneumatic transmission of power in the air brake, it was a logical development to use it for operating railroad switches; and in working out the details of the mechanism, Mr. Westinghouse, who was familiar with electrical practice as then developed, found that this agent could be usefully applied. This led to his taking a more active interest in electrical matters, so that he was one of the earliest to see the immense possibilities in the application of electricity for lighting and power.

This led him to acquire the control of some important electrical patents covering the use of alternating currents, and to form the Westinghouse Electric & Manufacturing Co. for the manufacture of electrical machinery, where he surrounded himself with progressive electricians, many of whom are still connected with that company. No one but a man of Mr. Westinghouse's invincible determination, persistence, and courage could ever have developed the use of the alternating current as he has done. It was opposed by the older electrical companies, who did everything in their power to prevent its introduction. The effort was made in some States to get laws passed forbidding its use, and when electrocution was adopted in New York, underhand means were employed to purchase a Westinghouse alternating dynamo, in order to make it appear that the alternating current was intrinsically more dangerous than direct current. In spite of all these obstacles Mr. Westinghouse persevered, and his first great triumph was the lighting of the World's Fair at Chicago in 1893. Here again the wonderful characteristics of the man as inventor, mechanic, and man of affairs were admirably displayed. He took the contract for lighting the fair at a price more than a million dollars less than had been offered by other companies. They, in the effort to crush



MAIN AISLE, WESTINGHOUSE ELECTRIC & MANUFACTURING CO., EAST PITTSBURGH, U. S. A., WHERE THE
HEAVIEST ELECTRICAL WORK IS DONE

him, endeavored to persuade the exposition authorities that he could not secure adequate bonds that he would carry the scheme through, and it is an actual fact that he furnished three separate bonds equal to the amount of the contract. After the contract was taken it would have seemed to an ordinary man as though everything was conspiring against him, for injunctions were obtained to prevent his using the Edison patents in the manufacture of the lamps, as well as the air pump for exhausting the bulbs, which was at that time supposed to be the best. Mr. Westinghouse himself invented another form of lamp.



MAIN MACHINE SHOP, WESTINGHOUSE MACHINE COMPANY, EAST PITTSBURG, PA., U. S. A.

known as the "stopper pattern," and not only invented the lamp, but invented and built machines for the accurate grinding of the stoppers and the necks of the bulbs. He also developed a special form of air pump to secure the exhaustion. All the world knows how beautifully and successfully the World's Fair was lighted, and it is a fact that the million-dollar surplus which was distributed to the stockholders is just the amount that Mr. Westinghouse saved these stockholders by taking the contract for the lighting. This was the largest installation of alternating-current apparatus which had been made up to that time, and all who visited the Chicago Fair will remember the section of Machinery Hall which was occupied by the Westinghouse generators. His next great triumph with alternating-current generators was the Niagara installation, which was by far the greatest electrical installa-



LIGHT-WORK DEPARTMENT IN THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY'S PLANT, EAST PITTSBURGH.

Above is shown "Section E" of the winding department; below is a section of the "Detail Department." These are in wings of the main building, of which the center is shown on page 537.

tion which had been planned up to the time of its inception. Here again his courage never faltered, and the results have shown that it was not misplaced.

Another characteristic of Mr. Westinghouse stands out very prominently in connection with the next great development in alternating-current apparatus, namely, his willingness to examine promising schemes which are presented to his notice, and if, after careful examination, he believes them of value, to have no hesitation in spending both time and money in experimentation to develop them and bring them to complete success. As is well known, Mr. Westinghouse gave his help in this way to Tesla in the development of multiphase apparatus, and particularly what is known as the "induction motor," which really made the electrical transmission of power simple and completely successful. In this development Mr. Westinghouse's own practical skill and sound judgment were of great value. The same thing has occurred with a number of other devices which, although originated by others, have been brought to perfection by the experimental work carried on under the direction of Mr. Westinghouse and at his expense. A notable instance is the Nernst lamp, which seems destined to create a revolution in electric lighting, inasmuch as by means of this lamp a given amount of illumination can be secured with less than half the expenditure of current required by the best incandescent lamps. When Mr. Westinghouse secured control of the Nernst patents for America the basic principles of the lamp were known, but it was entirely a laboratory device, and anything but a commercial article. He put several of his brightest engineers and physicists, with the assistance of a corps of skilled workmen, at the problem of perfecting the details, and this has now been practically accomplished, after a large expenditure of money. There could not be a better illustration of the fact that the opinion so often entertained about inventions is entirely erroneous, namely, that some man by a happy thought, or an accident, makes a discovery which brings him in a large amount of money without any effort or expense. The development of the Nernst lamp has gone on for a long time, has involved a very large expenditure, and if its commercial development should result in a great reward it will have been fully earned.

Mention has already been made of Mr. Westinghouse's connection with signaling and switching pneumatically, and this has developed into another large industry—the Union Switch & Signal Company, with the details of which he is thoroughly familiar. Besides this, there is another large company called after him—the Westinghouse Ma-

chine Company—which manufactures steam and gas engines and steam turbines. The manufacture of steam engines was perhaps natural enough, although even here the Westinghouse engine is a special type designed to accomplish special results. The gas engine, however, might not be expected to be a necessary adjunct, but Mr. Westinghouse's work in developing the use of natural gas led him to realize the possibilities of the gas engine, and he himself believes that his work in this respect is likely to add as much to his reputation as the air brake. While following in some respects the standard form, the Westinghouse gas engine has some very important points of difference which have made it much better adapted to practical work than any of the forms which have preceded it. This receives a large amount of personal attention from Mr. Westinghouse, and he believes it is capable of still further improvement, which will make it a decided rival of the steam engine, if indeed it does not ultimately supplant it. It will occur at once to those at all familiar with the subject that for this to be a possibility there must be a cheap and available form of artificial gas, and it is pretty well-known to those interested in such subjects that Mr. Westinghouse has been successfully devoting his own attention, and that of an able scientific staff, to the development of such a form of gas.

It is not so well-known as it deserves to be that Mr. Westinghouse developed the use of natural gas so that it became the convenient servant which it now is to large areas quite remote from the immediate gas fields. The most important feature in the use of the gas (its piping from the gas wells) is due almost entirely to him, and indeed the Philadelphia Company in Pittsburg, which still controls the natural-gas distribution for that region, was created by him; he was until very recently its leading spirit, only severing his connection with it after the handling of the gas had been placed upon a firm basis and he felt that he could no longer give attention to this subject, because of the demand upon his time for his other interests.

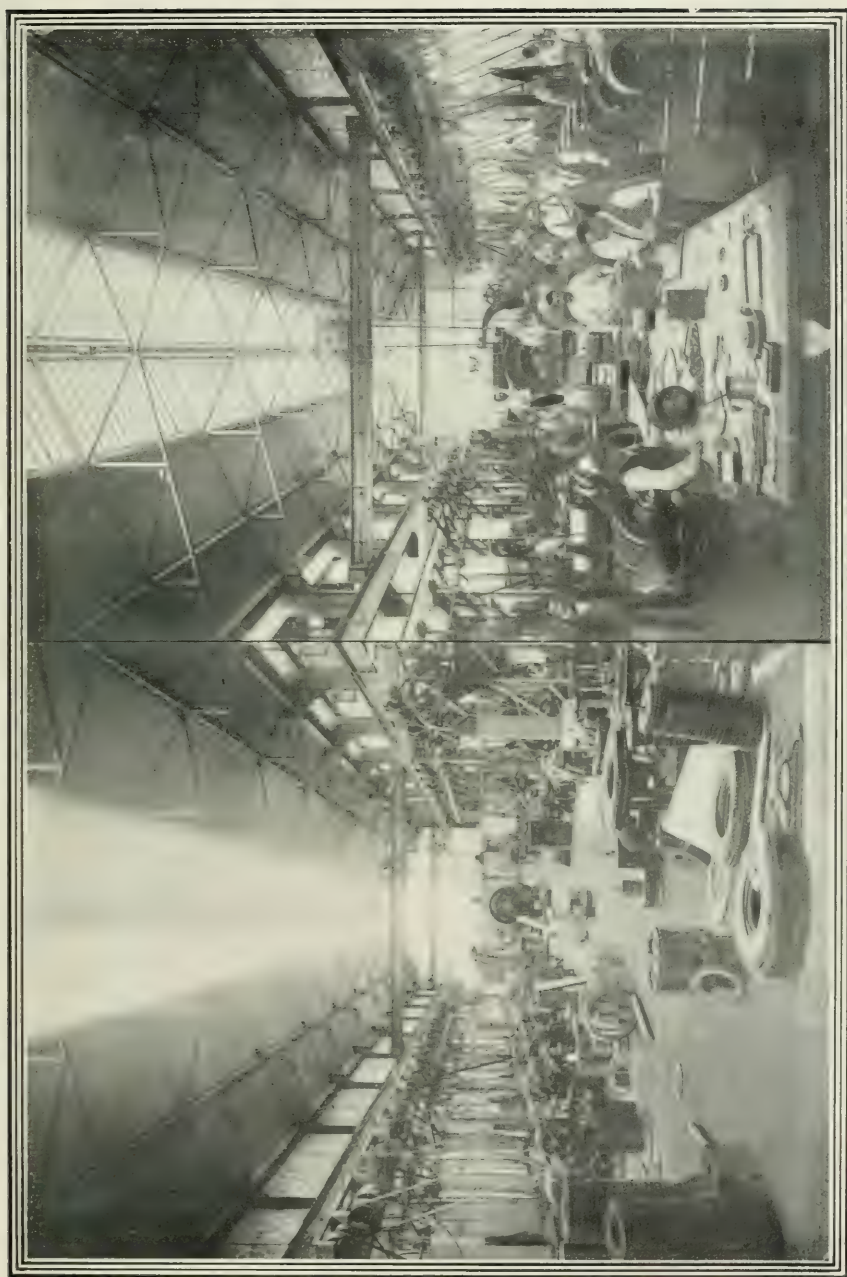
Besides the great works near Pittsburg, which are best known to the engineering world, there are factories for the manufacture of the Westinghouse brake in England, France, Germany, and Russia, and there are now building in England works at Manchester, to be called "The British Westinghouse Electric & Manufacturing Company," where there will be manufactured the same articles as in the electric and machine companies in America. There is also a French Westinghouse Electric Company, with large works at Havre.

This is a very brief and wholly inadequate sketch of the work

done by this wonderful man, who is not yet fifty-four years of age, but who has accomplished in thirty years more than almost any ten industrial leaders working each in one line have done in the same time; but the space permissible precludes a more extended sketch. No doubt it will be of interest, however, to state briefly what are the characteristics, as they show themselves to those who have been thrown with him intimately, that have contributed to his success and to making him one of the very foremost of the great captains of industry of our time. As showing his own modesty, it may be mentioned that Mr. Westinghouse himself attributes his success to hard work, and there is no doubt that this has been a very important element. Even now he works harder than any one of his many assistants, but it is, of course, obvious that hard work alone would not give such results. First of all comes his genius as an inventor. This was the foundation. Then comes intimate personal knowledge of mechanical processes and skill in the use of tools. It will have become evident in looking over the sketch of his life that no one but a man possessed of great intellectual capacity and keenness could ever have acquired the personal acquaintance with so many varied phases of engineering. This enables him to be the master of his great works, all of which he has personally planned, and those who know him best understand that, while he does not attempt to direct their routine, he nevertheless is fully acquainted with all the details, is able to discuss them thoroughly with those charged with their prosecution, and that he takes a keen personal interest in everything new and progressive, so that when he walks through his shops he knows just how work is going on, and if the progress has not been what it should be he calls attention to it at once. In this respect he is probably without a peer among the great industrial leaders. Many of them, as is well known, are not technical men at all, and those who are are limited to one particular line. As has been shown, the range of his knowledge covers a very large portion of the entire field of engineering.

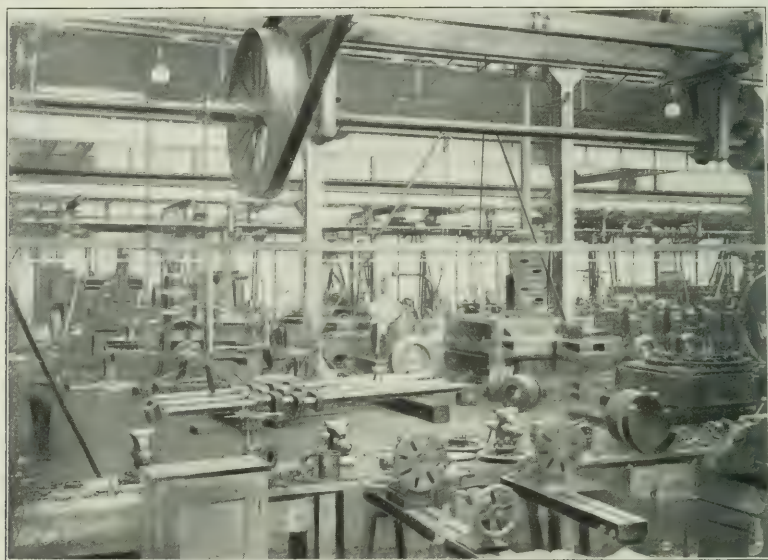
It would be a very natural inference that a man of such great mental power and tremendous capacity for work must also be of powerful physique, and such is the fact. Mr. Westinghouse is a splendid type of physical manhood, standing over six feet, and would attract attention anywhere. It is this physique, combined with a temperate life and cheerful disposition, that has enabled him to endure the enormous work which he has already accomplished and is still doing.

Mr. Westinghouse has the true spirit of the inventor, combined



INTERIOR VIEWS IN THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY'S WORKS AT HAVRE, FRANCE.

with the keenest mechanical judgment as to usefulness and adaptability, so that he is always seeking improvement in the apparatus manufactured in his various works. It is this spirit which makes him willing to examine promising inventions by others, and when they commend themselves to his judgment he does not hesitate to spend



INTERIOR OF WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY'S WORKS.
HAVRE, FRANCE.

time and money in their development. He is never willing, however, to attempt the commercial exploitation of any apparatus until it has been tested thoroughly, not only upon an experimental or laboratory scale, but on a working scale of large dimensions. This, of course, means the expenditure of large sums of money and the courage of one's convictions. The remarkable business talent, courage, and executive capacity of Mr. Westinghouse have already been mentioned, and undoubtedly these are extremely important factors in his success. There are numerous instances where great enterprises have been built up by business men, based upon the inventions or technical skill of others, but Mr. Westinghouse is the rare combination of the inventor with the keen man of business and the resourceful executive.

A striking illustration of his shrewd foresight, courage, and splendid common sense is shown in the planning of the two great establishments at East Pittsburg, Pa., the Electric and the Machine Works. These were built at a time of great business depression, and most people thought they were altogether too large for any probable

increase of business. Instead of a number of shops of moderate size, they were planned as a few large buildings, and room was left at both ends for extension when it became desirable. In five years after their construction, the extensions at both ends have been put on, owing to the growth of business, without any interference with the prosecution of regular work. The system of separate small buildings would have involved much greater expense with reduced efficiency.

One marked trait of character is his absolute integrity. Not a penny of his wealth has been acquired by stock manipulation or sharp practice of any kind. A very marked illustration of this could be told in a case where he disposed of his large interests in an enterprise of which he was the principal owner, and where, although he was offered a satisfactory price himself, he refused to sell until exactly the same offer had been made to all the small stockholders. These believed in him and had made their investment because he was directing the enterprise, and his loyalty to those who had trusted him made him look after their interests until he was sure that they could be placed beyond any mishap.

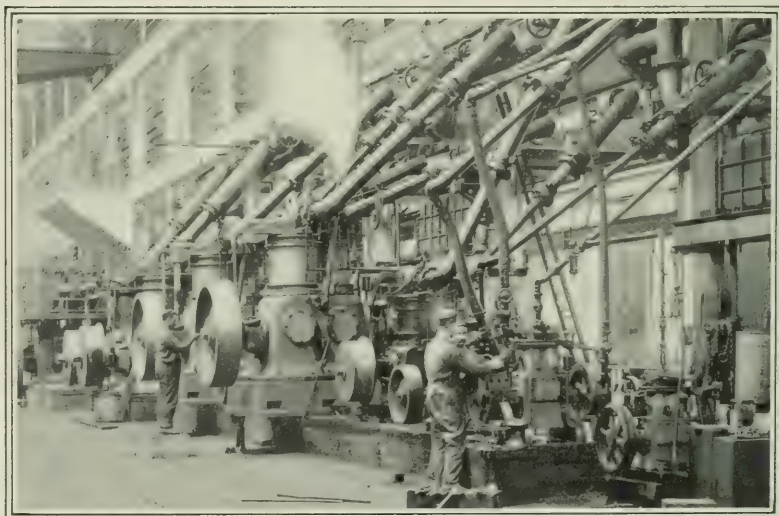
It might be possible for a man to possess all the characteristics which have been mentioned and still fail of complete success, for, after all, with such varied interests the man of greatest capacity must depend upon subordinates for carrying out his ideas; but Mr. Westinghouse has other characteristics which attach to him his subordinates, so that he is sure of the most faithful and loyal service. His sympathy, kindness, and tact in his relations with his subordinates are remarkable and make him personally one of the most agreeable and attractive of men. The popular idea, perhaps, of a man who has done such wonderful work and achieved such distinction is a man inaccessible to all except others of his own standing, and one whom subordinates would approach with fear and trembling. Nothing could be wider of the mark than such an idea as applied to Mr. Westinghouse. His subordinates are all his friends, thoroughly devoted to him, and counting it a pleasure to give their very best efforts to increasing his success. He is exceedingly hospitable, and while at his home in Pittsburg is fond of surrounding himself with his lieutenants and younger assistants, who always enjoy an evening spent with him, which usually involves a very interesting discussion of the latest developments in science and manufacture.

As already intimated, Mr. Westinghouse is an extremely modest man, and, while fond of entertaining and of making others happy, is altogether averse to mere display or ostentation. He is very generous

in a quiet way, in which he has the hearty co-operation of his charming wife. He has one son, who is just about to enter college.

During nearly all of Mr. Westinghouse's mature life his home has been in Pittsburg, and in view of his great enterprises, of which that city is the center, employing more than ten thousand operatives and having a capital of over fifty millions of dollars, it can readily be understood that he is one of the great men of the city and highly esteemed by all the citizens.

It is difficult in writing about such a man as Mr. Westinghouse to avoid the appearance of overdoing the matter and running into mere laudation, but this is simply because his career is so remarkable a one and covers so wide a field of effort. Those who know him best will say that this sketch is altogether inadequate and by no means does him justice. There are, indeed, many interesting events in his history which if related would shed still more light upon the qualities that have contributed to his success, but enough has been said to give some idea of the man and his work. There is much in his career to encourage all young men, for some of his merits are the homely ones which all may cultivate. The remarkable combination, however, of great business ability and executive capacity with inventive genius and technical skill is so rare that we realize these are gifts of nature, and are the qualities which enable a man to inscribe his name high up on the roll of fame and to become one of the great benefactors of humanity.



Testing Floor for Steam Engines, Westinghouse Machine Company.

GREAT WORKSHOPS OF THE WORLD.

A Series of Photographic Reproductions.

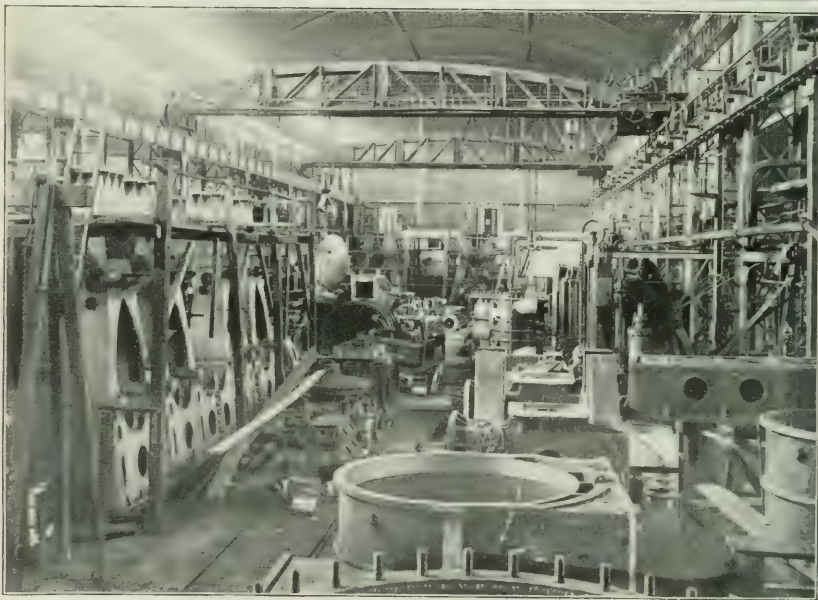
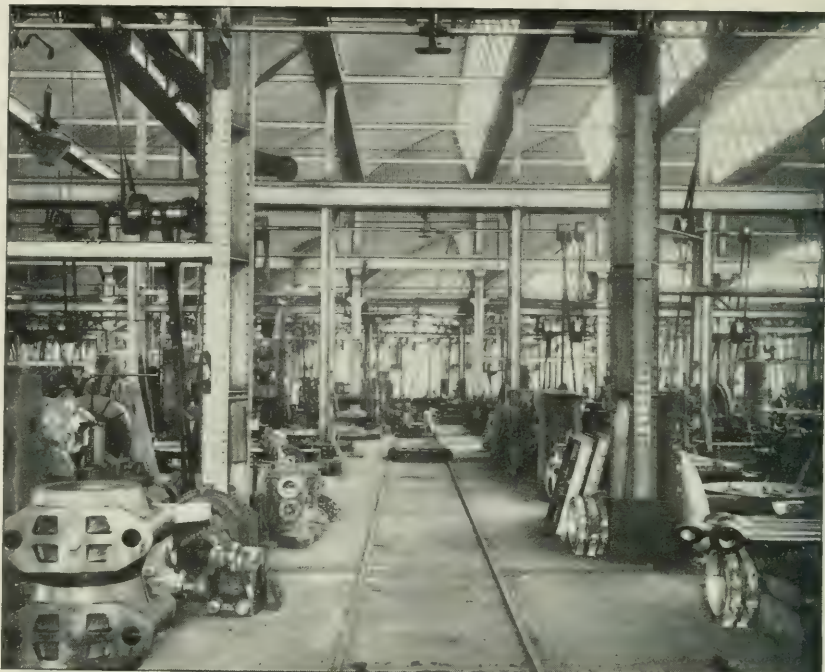


DESCRIPTION and direct illustration of highly-successful plants have peculiar value for the practical man. In the following pages of engravings, and in similar groups further on in the volume, there are brought in the concrete before the eye of the reader the general arrangement, the special equipment, or the characteristic features of a few of the foremost engineering and metal-working establishments of Europe and America.

Thus, in supplement to the four preceding critical reviews, a panorama is afforded of the most interesting sections or most suggestive features of the world's large workshops. The story of the pictures is made clear by explanatory comment beneath, and the utmost use is thereby made of the available space. It is clearly impracticable to include more than the very greatest establishments—those which by the magnitude of their operations, the range of their distributed products, or the excellence of their output, have become typical of the industrial progress of the land where they have their home. They epitomise the practice of works management, the principles of which are formulated and codified in every issue of *THE ENGINEERING MAGAZINE*.

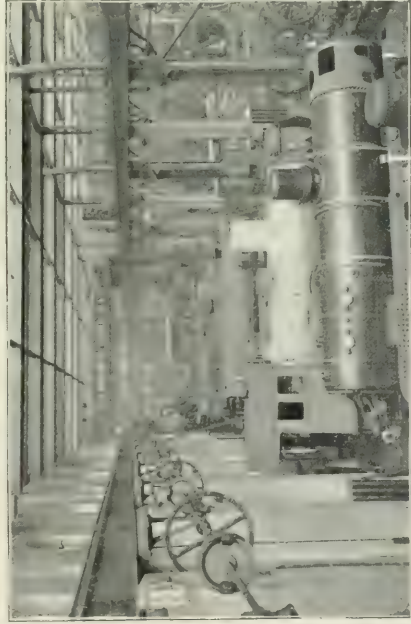
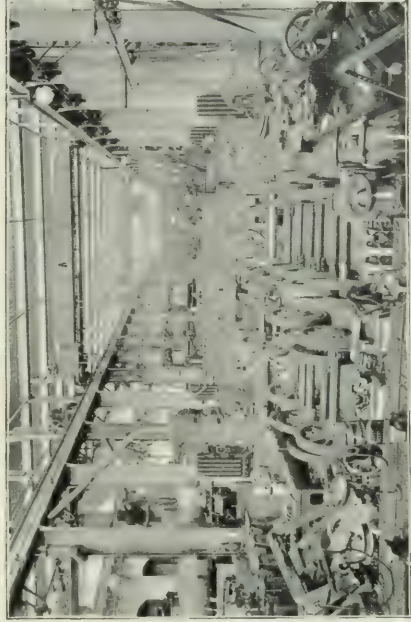
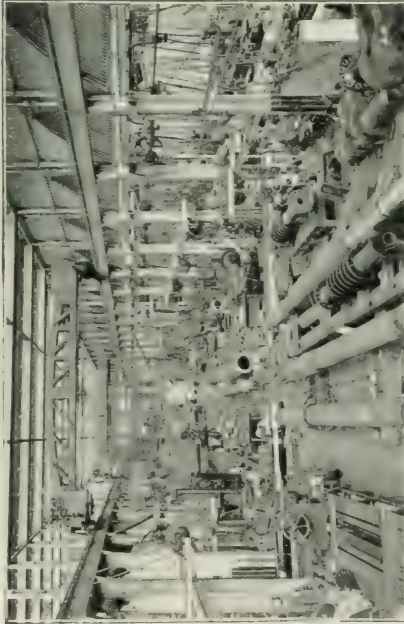
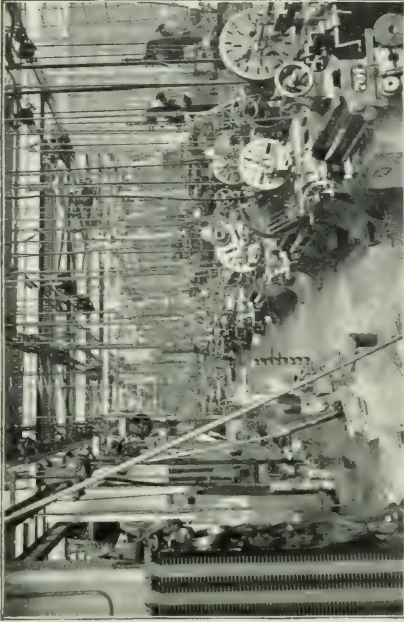


In the Westinghouse Air-Brake Works, Showing the Extended Use of Automatic and Semi-Automatic Turret Lathes in Repetitive Production.



LATHE SHOP AND PART OF ERECTING SHOP OF THE VULCAN WORKS AT STETTIN,
GERMANY, THE BUILDERS OF THE TRANSATLANTIC RECORD BREAKERS
DEUTSCHLAND AND KAISER WILHELM DER GROSSE.

Germany's industrial rise is nowhere more marked than in marine construction. Illustrations of her mechanical progress are therefore fittingly drawn from the champions in her struggle for supremacy on the sea.

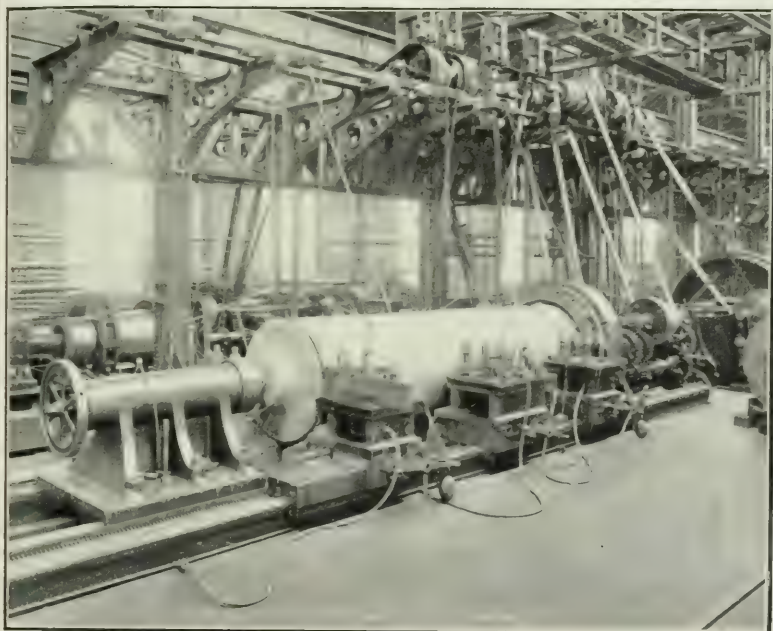
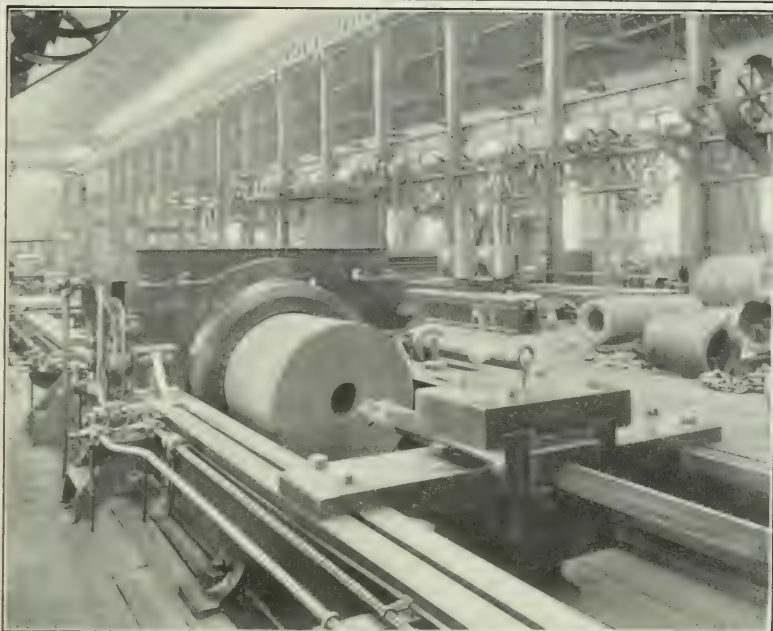


FOUR DAYS IN THE LOCOMOTIVE AND LATHE SHOPS OF THE VULCAN WORKS AT STETTIN.



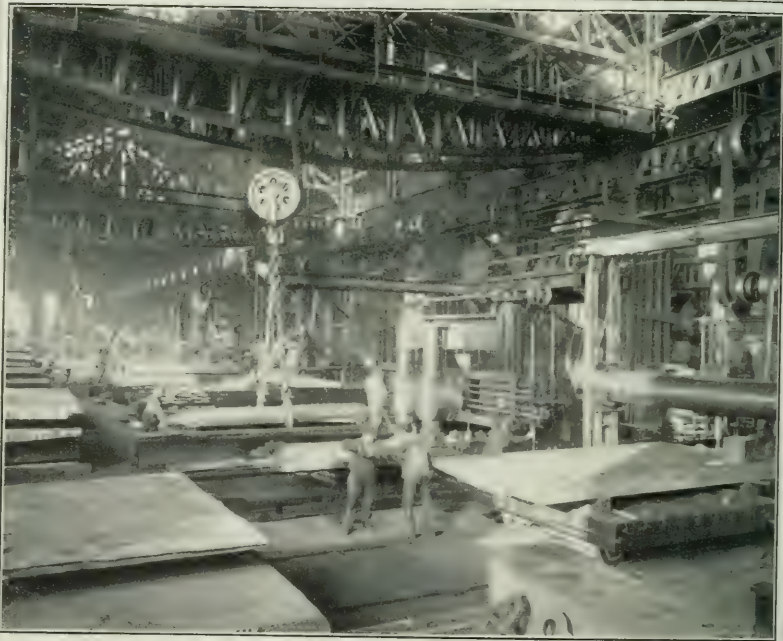
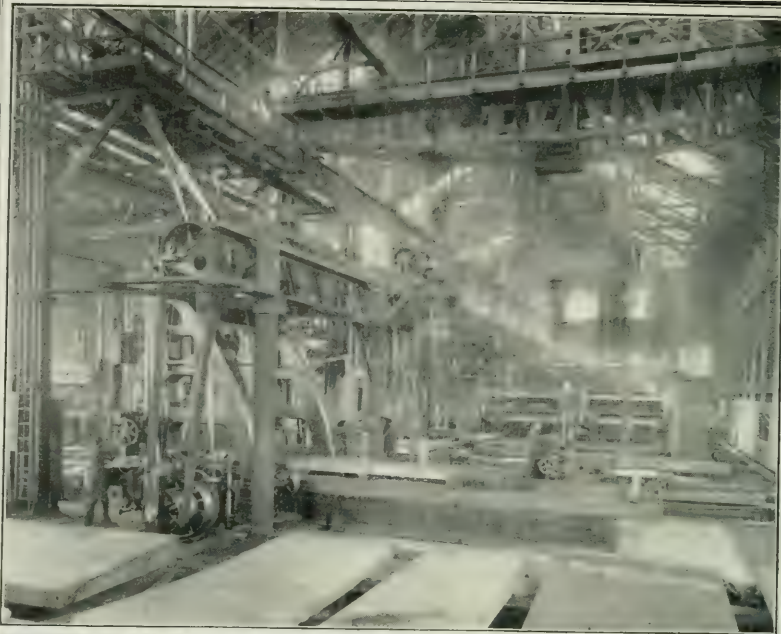
PLANT OF THE BETHLEHEM STEEL CO., SOUTH BETHLEHEM, PA., U. S. A. OPEN HEARTH FURNACES AND GUN-FINISHING MACHINE SHOP.

This company shares with Carnegie the largest contracts for armour plate, and leads American plants at least in the making of ordnance. The open-hearth plant is 62 feet long, and contains one 10-ton, one 20-ton, and four 40-ton acid and two 40-ton basic furnaces, with Siemens' gas producers. The gun-finishing shop is a sub-department of the main shop shown on page 552. It contains all machinery necessary for finishing the parts of guns of all calibres, before and after assembling, as well as their breech mechanism. Gun carriages and mounts are assembled here.



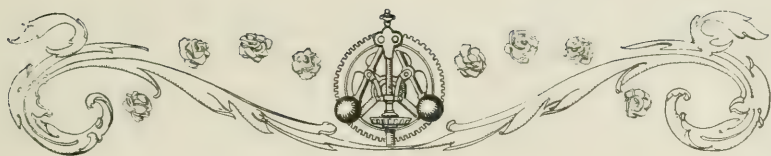
CUTTING AND BORING A FLUID-COMPRESSED INGOT, BETHLEHEM STEEL WORKS,
SOUTH BETHLEHEM, PA., U. S. A.

After clearing the sand from an ingot, it is swung in a powerful lathe and cut into blocks of the length requisite for the forgings desired. For hollow forging, the center of the block is bored out on a horizontal boring mill. The one shown has a central driving head, with boring bars at both ends, and takes work 60 inches diameter, boring a 20-inch hole.



VIEWS IN THE MACHINE SHOPS OF THE BETHLEHEM STEEL CO.

The armour-plate shop, above, is equipped with tools of enormous size and power, together with portable drill presses, grinders, etc. Here the groups of armour are assembled in the position they will occupy on the vessel, and are finally inspected. The general machine shop, below, is the heaviest of the plant, being $1,375 \times 117\frac{1}{2}$ feet. It is of steel and brick, with a central span of 60 feet, served by six electric cranes of 25 to 75 tons' capacity: there are four 10 to 25-ton electric cranes in the side aisles.



USES AND ABUSES OF ORGANISATION AMONG EMPLOYERS AND EMPLOYEES.

WHAT EMPLOYERS MAY PREVENT AND EFFECT BY UNITED ACTION.

By Sir Benjamin C. Browne, D. C. L.

PROBABLY we still all agree that in Great Britain the period from the conclusion of the great engineers' strike in February, 1898, up to the summer of 1900 has been very free from disputes, compared to any other period where there was an equal demand for labour. Not only has the engineering trade been very busy, but nearly all other trades, especially all branches of iron trade, coal mining, and building, have been at an extraordinary pressure. The war in South Africa has added to the pressure and reduced the available amount of labour, and yet things have kept quiet, and it is now our business to consider if this is due in any degree to the way in which the strike was settled, and if so, to what extent.

Now as there is no official manifesto on the part of the employers stating their views on the question, it is to be clearly understood that no paper can be more than the view of a private individual, who, however well informed he may be, can only speak of what he sees himself and the ideas he has formed thereon.

It may be well just to call the reader's attention to some of the main features of the strike that began in July, 1897, and ended in January, 1898. For a long time there had been great tension and frequent disputes between the Amalgamated Society of Engineers and

The most striking and most important tendency of the times is that toward concentration—toward the gathering of smaller units into centralised or harmonised bodies—toward the blending of many individual forces into a great single unified power. It shows in the federation of states, in the rapid growth of cities, in trade combinations, in the centralisation of the power plant, in the labour-union movement, and still more lately in employers' associations. The organisation of manufacturers and workmen, in which some have feared lay the menace of industrial war, far-seeing leaders look upon as the most hopeful foundation upon which to build a peace which shall be lasting because it is just—because organisation so consolidates both interests into tangible, responsible bodies that complete conference, mutual understanding, and trustworthy agreement become possible. There is no more interesting topic in the whole labour question than is here discussed by Sir Benjamin Browne, as an employer, and in the succeeding article by Mr. Barnes, as a labour leader.—THE EDITORS.

their employers, chiefly, but not entirely, on questions connected with shop management. The districts chiefly involved in them were the Tyne, Wear, Tees, Clyde, Belfast, and Barrow, spreading onwards into Yorkshire. A conference was held about Easter, 1897, in Westminster, at which some matters were provisionally settled; but the eight-hours question cropped up in London, and the employers, believing this likely to be a national question, took up the cause of the London firms and locked out in their support. Numbers of other employers in various parts of England joined, and the matter became a trial of strength between the Amalgamated Engineers, the Steam-Engine Makers, and some other unions, and their employers. To pass over the history of the struggle, the eight-hours demand was withdrawn in January, 1898, and certain terms were agreed to in conference, called the "Conditions of Management." If we wish to follow the industrial history of the trade, we must dwell on these a little. The employers honestly believed that a large discretion as to works management must be left with the employer, who is responsible for all taking of orders, competition, prices, excellence of work, profit and loss. But the following extracts will give a clear idea of the settlement:

"GENERAL PRINCIPLE OF FREEDOM TO EMPLOYERS IN THE MANAGEMENT
OF THEIR WORKS."

"The federated employers, while disavowing any intention of interfering with the proper functions of trade unions, will admit no interference with the management of their business, and reserve to themselves the right to introduce into any federated workshop, at the option of the employer concerned, any condition of labour under which any members of the trade unions here represented were working at the commencement of the dispute in any of the workshops of the federated employers; but, in the event of any trade union desiring to raise any question arising therefrom, a meeting can be arranged by application to the secretary of the employers' local association to discuss the matter.

"Nothing in the foregoing shall be construed as applying to the normal hours of work, or to general rises and falls of wages, or to rates of remuneration."

"1. Freedom of Employment.—Every workman shall be free to belong to a trade union or not, as he may think fit.

"2. Piece Work.—The right to work piece work at present exercised by many of the federated employers shall be extended to all members of the federation, and to all their union workmen.

"3. Overtime.—When overtime is necessary the federated employers recommend the following as a basis and guide: That no man shall be required to work more than 40 hours overtime in any four weeks after full shop hours have been worked, allowance being made for time lost through sickness or absence with leave.

"4. Rating of Workmen.—Employers shall be free to employ workmen at rates of wages mutually satisfactory. They do not object to the unions or any other body of workmen in their collective capacity arranging among themselves rates of wages at which they will accept work, but while admitting this position they decline to enforce a rule of any society or an agreement between any society and its members. General alterations in the rate of wages in any district or districts will be negotiated between the employers' local association and the local representatives of the trade unions or other bodies of workmen concerned.

"5. Apprentices.—There shall be no limitation of the number of apprentices.

"6. Selection, Training, and Employment of Operatives.—Employers are responsible for the work turned out by their machine tools, and shall have full discretion to appoint the men they consider suitable to work them, and determine the conditions under which such machine tools shall be worked. The employers consider it their duty to encourage ability wherever they find it, and shall have the right to select, train, and employ those whom they consider best adapted to the various operations carried on in their workshops, and will pay them according to their ability as workmen.

"Provisions for Avoiding Disputes.—With a view to avoid disputes in future, deputations of workmen will be received by their employers, by appointment, for mutual discussion of questions in the settlement of which both parties are directly concerned. In case of disagreement the local associations of employers will negotiate with the local officials of the trade unions. In the event of any trade union desiring to raise any question with an employers' association, a meeting can be arranged by application to the secretary of the employers' local association to discuss the question. Failing settlement by the local association and the trade union of any question brought before them, the matter shall be forthwith referred to the executive board of the federation and the central authority of the trade union; and pending the question being dealt with, there shall be no stoppage of work, either of a partial or a general character, but work shall proceed under the current conditions."

"NOTE—A grievance may be brought forward for discussion either by the workman individually concerned, or by him and his fellow workmen, or by the representatives of the union.

"In no instance do the federated employers propose conditions which are not at present being worked under by large numbers of the members of the allied trade unions. The federated employers do not want to introduce any new or untried conditions of work, and they have no intention of reducing the rates of wages of skilled men.

"These conditions, with relative notes, are to be read and construed together."

The above are extracts and not a complete copy. The most interesting and important point is that called "provisions for avoiding disputes," as great numbers of vexed questions have under these been brought before the central authorities of the two sides, and have been settled peaceably. Of course, this may not always be the case, if the court of final appeal cannot agree; there is nothing beyond it, and a trial by force might again arise.

Some of these conditions the men avowedly dislike, and in other cases they object to the interpretation put on them; the agreement very possibly needs revision in detail, but there ought to be no difficulty, either in engineering or any other trade, in arranging terms which would be fairly satisfactory to an unprejudiced mind.

Personally I think that the above, if not perfect, was at any rate a genuine step in the right direction, and if the working out has not always been so satisfactory to the men as they might wish, it must be remembered that after a struggle it is very seldom that the defeated party is able to meet the winners quite on equal terms.

But, as it is quite obvious that a strike is the result of very serious divergence between the views of employers and workmen, perhaps the fairest way to look on the question is to consider first what would be the ideal position for the employers and workmen to occupy between themselves, and then see how near we have approached this ideal.

I have always held, and I believe most fair-minded employers and workmen hold, that the best position for negotiations to be carried on between capital and labour is that of *absolute equality*, and that neither side ought to wish to have any advantage over the other, and if all questions could be settled on the basis of justice, fair play, and the general good of the trade, it is quite clear the question as to which was strongest would not be of any importance, or enter at all into the calculations of either side. It is only because of the possibility of an appeal to brute force that these things have to be borne in mind.

I fear we are a long way off this ideal, but there is no doubt that every step towards it is a very great gain to both sides and to the prosperity of the country; and I may say, as I have often said before, that I do not think on the whole the relation between employers and workmen is so unsatisfactory as it is sometimes said to be. There are probably at least six million males in the United Kingdom, working as mechanics or labourers. Each of these men has his own difficulties, his own feelings and prejudices, and probably every now and again some real hardship and sometimes injustice to be borne; and I think on the whole the wonder is not that we sometimes have strikes and difficulties, but rather that we do such an enormous amount of work so smoothly as at present.

For example, the engineering, and ship-building, and I might add the coal and iron trades, have gone through a time of unprecedented prosperity and high pressure since the beginning of 1898, and during that time there has been comparatively little friction; there has been regular employment, and a very large amount of work has been turned out, presumably to the satisfaction of the purchasers.

Our difficulties, speaking both for ourselves and our workmen, attract attention on account of the number of us there are in the world, and therefore the absolute size and frequency of these disputes, not on account of their relative size and frequency; compared to our numbers, I think the proportion of difficulties that are not settled amicably and by mutual forbearance is very small indeed.

Of course, one great point is to make up our minds whether we think it better there should be trades unions or not. My own feeling has long been that large unions, both of workmen and of employers, are by far the most satisfactory. All disputes then, before they can lead to stoppages of work, are taken away from the original disputants and are brought before selected employers and workmen of knowledge and experience in dealing with such matters; men who know each other well personally, and who have usually established a friendly and to a great extent confidential footing with each other, and numbers of disputes which would lead to a stoppage of work, if they had to be settled between an employer and workmen in the works, get smoothed away and settled amicably by the time they reach the last court of appeal.

The late Col. Dyer, whose name was so well-known during the strike of 1897, was always very anxious to keep to the front the fact that the employers did not want to smash the trades unions. I think the settlements that he made, not only in connection with this strike

but on previous occasions with the boiler-makers and other bodies, showed that such was his consistent conviction, and the special settlement after the 1897-1898 strike as above shown proves this conclusively.

The demands which may be made by workmen and cause friction may be roughly classified under four heads:—

1. Demands which benefit the workman, and are not injurious to the employer.

Personally under this head I should include such a matter as weekly pays. They were a certain amount of trouble to introduce, and no doubt they involved a certain, but not a large, amount of extra expense; but I think it is a very great benefit to the workman to be paid as often as possible, and I think his money goes further, so that the remuneration paid, without costing the employer appreciably more, is of really greater value to the workman, and so the service in which he is engaged is made more attractive without increased expense.

2. Demands which are beneficial to the workmen, and which at a greater or less sacrifice the employers can afford to give.

Such as this would be a moderate rise of wages.

3. Demands which are beneficial to the workmen but which the employer cannot afford to give, either on account of his own interests or on account of the trade.

Under this head would come a large increase of wages, which would more than absorb the employer's profits, or compel him to put up prices so high that it would throw a large number of men out of work.

4. Demands which are not really beneficial even to the workmen.

Under this head I should put all the demands for restriction of labour, such as restricting the amount of work a man is allowed to do, either as regards quality or quantity, all of which make his services less valuable and must in the long run reduce his own money value. Limitation of apprentices would also come under this head.

Of course it is impossible that all employers, and very much more impossible that all workmen, should think the same, and it is therefore wise to encourage the freest discussion and the freest individual expression of opinion, because the strength of either side is not that all the employers, or all the workmen, think exactly the same, but that they are prepared to defer their individual views to those of the majority.

To refer to those who suppose unions are an evil. I think they

take as an ideal some self-reliant workman, who has a very strong character, great self confidence, who can make his own bargains, and then they say: "If all men were like that how nice it would be." But they must know that all men are not like that. People who can take the lead and act entirely on their own self-reliance are very scarce in every relation of life, and what used to happen much more before unions were so strong was, that suddenly a feeling would rise up among a body of workmen that they were dissatisfied or offended, and that they ought either to have a large rise of wages or something else. A mass meeting would be called by the most violent of them, and the most extreme would force themselves to the front, the delegates would be elected by clamour, and then come as the representatives of the whole party of the workmen, saying they must have the most unreasonable concession or they would go on strike, and take such courses as a wise trades-union leader would never adopt. I think anyone who has known the labour market for the last thirty years will say that the demands are almost without exception far more moderate in their character than they used to be before the men were so much under the influence of the unions.

The emergency committee, which is the court of final appeal, usually consists of about a dozen members, half of whom are the leading members of the central council of the Amalgamated Society of Engineers, and the other half are selected engineer employers.

The questions that come before the committee may refer either to districts, single works, or individual men; they may be questions of wages, hours of work, allowances, or cases of misconduct, unfair treatment, or anything else.

It is, I think, a great gain to the men to feel that if any one of their members is harshly treated his case can be brought up before this highest appeal, and the possibility of having to justify one's action before such a tribunal must act as a controlling influence on every employer. I hope that harsh treatment of workmen has never been common, but this ought gradually to make it impossible.

We employers cannot speak as to what the workmen think of us, but there is no question that Mr. Barnes, the well-known secretary of the Amalgamated Society of Engineers, Mr. Sellicks, the president, at whose return to our meetings, after a long and serious illness, we all so much rejoice, and many of their colleagues, have impressed the employers very favourably by the way with which they have dealt with the various questions that have come before us.

USES AND ABUSES OF ORGANISATION AMONG EMPLOYERS AND EMPLOYEES.

THE OLD TRADE UNIONISM VS. WISELY-ORGANISED LABOUR.

By George Nicol Barnes.



TRADE unionism in Great Britain dates from the rise of the factory system of industry, the first twenty-five years of which were marked by an unexampled increase in the productivity of labour and a like increase of misery and degradation among factory operatives. In the absence of organisation, the new conditions told almost entirely in favour of the employing classes, and those who decry trade unionism would do well

to cast their minds back upon that period of unrestrained competition and make themselves acquainted with its relentless greed and biting poverty. Each employer had become, for the first time, a combination of employing power, and most employers subordinated every other consideration to a desire and determination to amass wealth.

Trade unionism was at first, however, but a crude attempt on the part of isolated groups or unions of men to maintain, or rather to re-establish, for themselves the old economic relationship. Political power was in the hands of the monied classes and had long been used as an instrument of oppression; public opinion was sluggish and wholly-uninformed as to the new industrial methods; hence trade unionism sought neither to utilise the one nor conciliate the other. Laws and learning had no attractions for the early unionist, and the greatest favour asked of either was to be left alone. Unions were, in fact, local and sectional in character and unionists were individualistic by instinct, having but little knowledge of the nature of the forces they were invoking, but driven to combination as a means of protection against harshness of industrial conditions. Time and the logic of events have changed the situation. Political power has passed into

It is most gratifying to see how nearly the ideals of advanced labour, as sketched here by a leader like Mr. Barnes, correspond with those of the employer, as set forth in the preceding paper by Sir Benjamin Browne. The reason is plain—both are conceived primarily in an earnest striving for right and justice. The situation, as it appears in the light of these two reviews, is full of hope and promise.—THE EDITORS.

the hands of the people and public opinion has become more alert as well as better informed. At the same time trade unionism has widened out in structure and in aim, now aspiring to regulate industry as well as to influence public opinion.

Turning now from generalities, let me endeavour to give a more-detailed statement of the principles and conditions upon which trade unionism is based. It assumes two things: first, that each class in the community—or at all events, the great mass of each class in the community—will always follow the line of self interest; and second, that workmen as a class, by reason of numbers and dependence and circumscribed lives as compared with other classes, must be organised in order to make their power and influence felt. And upon these two a third idea is being forced, alike by industrial development and by spread of altruistic teaching, viz., the unity of interest of all labour, whether of hand or brain. We have travelled far on the road to collectivism since the advent of the factory system of industry. Employers themselves have organised, first locally and then nationally, and the units of employing power have become larger with the centralisation of business in fewer hands. Still, trade unionism has maintained its character throughout as essentially a class movement, tending, however, to become a movement covering and working for the whole class instead of certain sections of it only. The groups have become larger in themselves, and, by absorption and amalgamation, fewer in number. In the last five years the number of unions has decreased from 1,317 to 1,267, while the number of unionists has increased from 1,404,898 to 1,644,591, some 400,000 men being enrolled in a federation of unions started a year ago. The distinctive features of the newer organisation have been the supercession of localism and the systematising of the principle of provident funds for the purpose of ensuring unionists against sickness, unemployment, or exceptional misfortune, as well as of providing annuities for old age.

Wider experience and fuller resources have been brought to bear on the settlement of local disputes, solidity and discipline have been added by the acquiring of vested interests in old-age funds through long years of membership. In this process of development the engineering unions have taken a leading part. Fifty years ago many of the local and sectional societies in the trade became merged in the Amalgamated Society of Engineers, which was the pioneer of the national societies. These national societies, like a modern Aaron's rod, have swallowed up most of the local and sectional societies which had existed fifty years ago, and are to-day the distinctive type of

English trade unionism, the Amalgamated Engineers being the largest, with a membership of 86,000. During the early part of their existence agitation was successfully directed to the abolition of such laws as still militated against freedom of combination and security of funds, and the last few years has witnessed increased attention being paid by them to the raising of the standard of life through the direct agency of public bodies, and the bringing together of all labour—skilled and unskilled—into closer union.

Let me here note a wide-spread fallacy frequently met with in the columns of technical journals like *THE ENGINEERING MAGAZINE*. The new unionism is frequently held up to opprobrium as the disturber of the peace in questions of demarcation of work and kindred troubles. The exact opposite is the fact. The new unionism seeks to prevent labour organisations being pitted against each other. Its leaders have actively opposed the fomenting of squabbles between rival trades. If at any time it has backed up the old unionism against an incursion of unskilled labour into a trade, it has not done so for the purpose of seeking privileges for one section at the expense of other sections of labour, but because convinced that such incursion would lead to over-specialisation with attendant evils. It accepts specialisation as inevitable, but desires to regulate the application of the newer methods arising therefrom, so as to make them harmonise with wider interests than those arising from mere considerations of production.

Again, the new unionism is often charged with restricting production so as to spread work and employment over a larger number of men. This may have been at one time and for the reason stated, and it should not excite surprise if workmen had thus interpreted the theories once current as to the sources of wealth and wages. Trade-union organisation has certainly been used at times to cover up malingering, but this by no means implies that trade unionism is responsible for a disposition, common to human nature, to rub along through life as comfortably as possible. It is no part of trade unionism, either old or new, to restrain production below a point consistent with the requirements of health and permanent efficiency. And the new trade unionist, at all events, knows full well that the larger his production the larger, other things being equal, will be his wages. But, while believing in a fair day's work, the trade unionist declines to be entirely guided by short-sighted views of production. He bases his case upon the broad basis of humanity, refusing to regard himself or his fellows as mere wealth-producing machines. Trade unionists, both old and new, claim for workmen a voice in the fixing of the general conditions

under which they shall work. Both are alike interested in protecting workmen from the admitted evils of piece work, from over specialisation of industry, from long hours of labour, and from low wages. If there is any difference between them on these points, it can be summed up in the different importance which each may assign to them.

It will, I think, be generally admitted that trade unionism has substituted discussion for violence in the settlement of disputes, and that it has enabled its leaders to acquire that caution and moderation which comes with a wider knowledge of affairs. But be it remembered that the safeguarding and promoting of the interests of workmen are its chief concern, and industrial peace only in so far as such is consistent therewith, as well as with conditions of employment which will bear the test of examination from the point of view of the workmen's interest. Unfortunately it cannot be said that the rules or terms of agreement to which the engineering industry of Great Britain is supposed to be at the present time working are consistent with the safeguarding of labour interests. Some three years ago, the engineering employers entered into a solemn league and covenant against the lessening of hours, and to secure for themselves absolute discretion in the disposition of labour in their workshops. After a seven-months' stoppage, work was resumed upon terms of settlement which, though considerably short of those originally attempted to be imposed on the men, still appeared broadly to give the employers the disposal sought. Whereupon there was much rejoicing among most, and a little boasting on the part of some, employers at the great victory achieved, and we were told that capital was henceforth to be "absolute master" and that labour was to be treated as an "inert mass." But alas for the vain delusion! I venture to say that the terms of settlement do not contain the elements of permanency and that in some respects they run counter to the reason and sense of justice of the great mass of engineering operatives, and even, I believe, of many of the employers themselves. Let me deal with them on two points: 1, Piece work, and 2, Machinery.

There are two ways only by which piece work can be wrought smoothly and with permanent advantage to employers and employed. Where standard price lists are possible, such may be arranged or agreed to by the employer and the union, and each man or group of men then be left to his own or their own resources. The alternative method—applicable where work is not sufficiently-standardised to admit of price lists—is that the employer should himself price the work (individual bargaining really amounts to that) but guarantee a certain minimum wage which should, I think, be a certain percentage

over and above the day-work rate. The former method safeguards collective bargaining as applied to standardised work. The latter safeguards the interests of both sides in the fixing of prices of other work, as it protects employers against workmen by the stimulus given to the latter to earn more than the guaranteed wage if the price will admit of it, and it protects the employed against employers inasmuch as, if employers reduce prices to that point which will just yield the day-work rate, workmen will drop into day-work speed and effort. Employers object to this guaranteed wage, because, they say, workmen have been content with such wage and have not exerted themselves to earn more when such wage was guaranteed. But surely such an argument from employers carries its own refutation and moral. It is a proof of the soundness of the workman's position, since it proves that employers had cut down prices to a point at which it was not possible to earn anything for extra effort. It is inconceivable that workmen would refuse to increase their earnings if they had a chance of doing so.* The Employers' Federation refuse to recognise or concede either of these two methods of payment of piece workers, and, as a result, workmen object to piece work altogether, though it is but fair to say that the practice of many employers has been a good deal better than the precept of the organisation of which they are members.

In regard to machinery, the federated employers claim to exercise a right to place any workman, irrespective of age or previous training (or the want of it), at any of their machines and under any conditions without objection being raised by the union. We hear much from some in advocacy of the "group" or "American" system, a feature of which we are told is the placing of a group of machines under the charge of one skilled piece worker with helpers. This system, it is said, leads to increased efficiency and therefore to increased employment, owing to an increased demand. It seems to be forgotten that it is not so much the amount of employment as the nature of it which forms the basis of the men's objection to the general adoption of this system. The enquiry naturally suggests itself to my mind as to whether or not there is any apprentice system in America and if so, to what are the lads apprenticed? It seems to me that, if what we are told be true, then the American workshops must be nearly filled by

* Inconceivable as this seems to a leader of Mr. Barnes' ability, or to any reasonable thinker, it has nevertheless remained for American organised labour to commit exactly this folly in its stubborn opposition to the premium plan. See Mr. Norris' paper on Actual Experiences with the Premium Plan in *THE ENGINEERING MAGAZINE*, Jan., Feb., 1900.—THE EDITORS.

what in Scotland are called "halfpins" (*i. e.*, half men) regimented by a few overlookers with an eye to bonus. I have not been to America, so that this may be a mistake on my part—perhaps the system, if in general vogue, may be carried out as an alternative to apprenticeship.

I do know that it is a laudable ambition on the part of British parents to give their lads a trade, and much sacrifice is made to do so, lads being put to the trade at very low wages (I myself started at 2s. 3d. per week, and I have a lad in his seventeenth year earning only 4s. per week). Surely employers who benefit by this cheap labour should admit its right afterwards to a voice in regulating the trade in which it thus acquires an interest. At all events, it is clear to my mind that the probationary servitude of lads in Great Britain entitles them in after life to take such steps as may be necessary to protect the trade from microscopic subdivisions which would reduce mechanics to mere machine-tenders, doomed to a dull round of narrow and uninteresting drudgery. The group system is applicable and, as a matter of fact, has been applied in Britain, without detriment to anyone, in the manipulation of automatic or semi-automatic tools, but its application to tools of a wide range of work is objected to by workmen as being, in their belief, unfair in principle and of more than doubtful advantage in practice, judged even from a productive point of view. At the same time, I freely admit the right of the employer to exercise an initiative in these matters, and I believe there has been, in times gone by, an undue interference with this right; but I submit that smooth and satisfactory working is not more likely to be attained by pushing things to one extreme than to the other. There is much to be said for a grading of labour and for its payment in some approximate proportion to skill; but, on the other hand, workmen have a right to expect that the interests of labour and of the community shall be considered, as well as those of the employers, in the manning of machinery. The time has long since gone when a mere assertion of ownership sufficed to justify absolute disposal of anything, when such disposal affects large numbers of people.

True, there are the "courts" for "avoiding disputes" and I want to say nothing which would seem to under-estimate their value. They have brought employers and employed together and enabled them to understand better each other's difficulties; they have accustomed both to reason out their differences, and they have averted stoppage of work and loss to all which comes with stoppage. But after all, they have their limitations. As at present constituted they but enable each side to ascertain the strength of the other as indicated by the perti-

nacity with which it clings to its argumentative position, and so they lead to avoidance of disputes as much through the wholesome fear of losing money as by any other consideration. They presuppose a right on the part of the employer to "do what he likes with his own," and they further, in certain respects, reserve to the employer the power of substituting individual for collective bargaining at will; on the other hand, they provide no reservation for workmen, either for reference in case of disagreement or for the maintenance of minimum conditions. Such "courts" can never reconcile conflicting interests; they cannot even exhaust the means of amicable and just settlement of disputes, since workmen sitting upon them know little of prices and less of profits, while the employers know everything of both and of wages as well. Hence the need for a "third party," fully informed, whose decisions would be more likely to be impartial because untainted by considerations of self-interest. Organisation will, I believe, necessitate a resort to arbitration courts in some shape or form. Conciliation boards are but half-way houses. Some day the community will step in and assert its right to a say in the matter. Probably this was undreamt of in the philosophy of the early organisers, either of capital or of labour, but it must be the ultimate outcome of the existence of rival organisations able to inflict injury upon industry in all its branches. Meanwhile there are problems confronting the trade which will be solved neither by masterful assertiveness nor by plausible theories contrary to the light of facts. In *THE ENGINEERING MAGAZINE*, May, 1900, I note that Mr. Charles Buxton Going predicts for specialisation but one outcome, viz.: "The raising of the former partly-skilled attendant to the grade of a far more highly-skilled tool-maker and designer." Mr. Going is evidently possessed of the faith that moves mountains, and endowed with the cheerful spirit of the man who was content that he had a whale of his own in the North Seas.*

Specialisation in the past has had no such result as predicted for it in the future, and, in the nature of things, it cannot have any such result. In the past specialisation has resulted in narrowing the field of individual activity of the mechanic. In the future, while making labour less varied, it may also make it more easy: while making labour more productive it may abridge—and should ere now have abridged—the working day: but to argue that specialisation will "raise" the mass of labour out of itself denotes a mere optimistic delusion.

* Mr. Going rejoins that this is preferable to the pessimism which refuses to believe there are any whales anywhere. The question, however, is admirably discussed by Prof. Higgins in the following article.—*THE EDITORS.*

It has been stated more than once in the columns of *THE ENGINEERING MAGAZINE* that the 1898 terms of settlement have caused some wonderful changes in the workshop and that they have "emancipated" industry from "pretensions" and "tyranny," from "drags and chains," and various other curious things said to be part and parcel of trade unionism. Of course the fair-dealing employer knows all this to be for the most part pure nonsense, and that it is just such writing as leads to friction. British employers generally know full well that there is but little practical difference in the workshop now, as compared with the time prior to '98, and that the real solid gain following the dispute has been the freedom from stoppage, consequent upon the facilities afforded for the discussion of differences.

I want to see those facilities maintained and even made better; I want to see them made the media by which the wisest counsel on each side may be made effective. Organisation on both sides on a large scale has for the first time made this possible, and the far-seeing men on either side will endeavour to use these organisations, not to obtain absolute mastery for one or the other, but to adjust differences on right lines. Settlements on wrong lines, effected either through power of money on the one hand or through the pressing of narrow sectional views on the other, can but dam up latent forces.

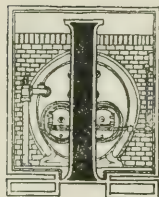
The engineering unions should frankly accept specialisation and adapt themselves to the changing circumstances; they should, I think, grade their membership from the highly-trained all-around mechanic to the machine tender who, owing to simplification of processes, cannot rank as an engineer but who is entitled to a guaranteed living wage. The employers on the other hand should frankly recognise the right of the unions to bargain collectively for their members.

This done, adjustments would, I believe, be simple enough and both sides might even find common ground for the use of their energies in freeing industry from unjust taxation and other vexatious conditions that now press upon it to the detriment of both.

The following sentence, taken from the preface to the rules of the Amalgamated Society of Engineers, fairly enough expresses the object of the trade unionist—new or old: "That we may leave to a future generation not only a trade, but the means of maintaining its best interests, until some more general principle of co-operation shall be acknowledged in society, guaranteeing to every man the full enjoyment of the produce of his labour." This was written fifty years ago and still stands as the best exposition in brief of the legitimate aim of the engineering operatives who are trade unionists.

INTENSIFIED PRODUCTION AND ITS INFLUENCE UPON THE WORKER.

By Milton P. Higgins.



INTENSITY is the present order of progress. Especially is this true in regard to mechanical and industrial progress. To this great modern force, this excessive effort for the highest efficiency of time and money, is due our modern system of intensified production. While the central motive of the system is greater output through the use of machinery and mechanical appliances, another element in the motive is the greatest possible improvement in kind and quality of every product, so that every producer aims with tremendous intensity to put upon the market an article *both better and cheaper*. The combination of these two factors, superiority and low price, produces a result marvellous in its effect upon the evolution of civilization. Better and cheaper; both these desiderata must be attained—neither quality alone can lead to the desired result.

In museums containing the choicest products of past ages may be seen things made with the sole object of superiority. The most skilful artisans have wrought a lifetime upon a sandal, a glove, a time-keeper, or some such useful thing, that might, if possible, excel all others, and have produced an article which was most exquisite in finish, but so costly that only kings and princes could possess one. But when the highest skill, the most scientific learning, and the most wonderful of modern machinery are combined and intensified, both poor and rich can be supplied with the best things. To produce the best and cheapest requires the highest degree of organization, the wisest selection of workmen and allotment of the work to him who is fittest for that particular grade of work by what we call "division of labor," in factory and shop, and "choice of specialities" in science and profes-

Intensified production—the great correlative of organisation in increasing economy of manufacture—is probably regarded with more groundless dread than any other phase of the new industrial system. Broad-minded employers, as well as honest labour leaders, fear to find in it influences narrowing to the powers and to the life of the individual workman. To all these there is a revelation and strong assurance in the eloquent presentation of the truth of the case, as seen by one of America's most successful employers and foremost students of the labour problem.—THE EDITORS.

sional life. This great modern effort to improve and to surpass has increased the speeds of our locomotives, our spindles, and our sewing machines. All tools and all machines are called upon to work faster and to produce from ten to one hundred times more than a few years ago. This calls for new and wonderfully advanced standards of machine design and construction, new principles to be considered, new mechanical combinations and methods to be invented. It requires stronger joints, reduction of friction, and superior metal, hardened and toughened to the greatest degree, to withstand the shocks and pressures brought upon it by the new conditions.

The effect of this demand upon the inventive and the engineering forces is a new dispensation, a world of opportunity to the educated mechanic and engineer. Regarding the great blessing flowing to the favored class of engineers, there can be no doubt; and so glorious and limitless is this enticing field of action that it would be interesting and profitable to discuss it at length were it not the intention of this article to deal especially with the effects of intensified production upon the masses of workers engaged in making things useful. The scientists, engineers, managers, superintendents, and foremen of industrial works taken together are, in point of numbers, an insignificant fraction of the vast army concerned in production and useful accomplishment. Every workman and every operative is just as much a man, with a body to be fed and clothed, a mind to be developed in some direction, with tendencies upward or downward, with habits good or bad, with a wife and babies to be supported, loved, or neglected, as the president or any one of the board of directors. What are their chances in this system of intensity? What is the importance to them of a proper conception of their chances? It is in attempt to answer these questions that this article is submitted.

There is a general impression that this so-called machine age, which is responsible for our system of intensified production, is an age not helpful to the laborer, but, rather, is degrading and debasing him. One listens to pathetic and eloquent talk about the poor operative, whose life is made narrow, dark, and sordid because he sits all day long tending a machine. I recently listened to this view from a prominent and influential Englishman, a member of Parliament, and a bright, able gentleman. "Why," he said, "what hope have we for the race with such a factory system as England has? I see men whose whole life consists in sitting by a machine simply to watch it drop a piece of wire out of one tube and see it enter another tube. What opportunity has such a man in such a divided labor system

through all the long hours of the day? I go to his home, which I find in an endless row of dingy, brown, box-like houses, one of a hundred, all just alike in the matter of brown dinginess, crowded poverty, and filth; and in this man's mind all of his dark environment is the result of this system of manufacture."

So it is believed generally by a sympathetic, unthinking people, that division of labor, automatic machinery, and piece work, constituting our system of production, is the cause of degradation, instead of a possible remedy for it. The condemnation of the system is not only untrue and unjust; it is very harmful. No greater mistake regarding the well-being of our working people can be made than this erroneous belief regarding our industrial system.

It is not denied that the sadness and lack of life and interest that constitutes the most depressing exhibition of human existence in low living is found in some shop and factory life in Europe and America. But the great mistake and the great harm come in ascribing the bad condition of life to the system. It exists in spite of the system, which has within itself an escape from the lower to a higher life.

The modern industrial system is far from perfect; it has injustice and hardships; but no other system, real or imaginary, has presented such practical and unlimited opportunities to the masses. In any other system of production only the skilful ones, the superior ones, can be given a fair chance. Now, as never before in all the history of the world, this great mass of unskilled workmen can have it. The best use that was ever thought possible for these poor masses by the ancients was to dress them in uniform and send them out in armies to be shot down or cut to pieces by the enemies of their rich rulers. To-day the masses have an opportunity of creating and acquiring. This is not a mean chance; it is a grand chance, and the best that God has provided up to this period of time.

What is this opportunity? First, opportunity and means for a decent existence. Second, a demand upon the individual for a little better thought and action. Third, opportunity to do and be a little better by personal effort. Fourth, relief from excessive muscular fatigue and unhealthful conditions. Fifth, better social advantages and conditions. Sixth, opportunity for culture and education.

Suppose a young man has no technical knowledge, no skill of hand; the modern system says: "Here is a so-called automatic machine. We want you to run this and be responsible for its performance." What is an automatic machine? It is one that carries within its conception and construction and in its productive functions

a storage battery of brains, so that it will probably go a little while when fed and tended by a thoughtless boy or a brainless man, who is set at it and started with instructions to do one only of the least things possible for him to do, if he will but think and will to do it. That storage battery of brains which is in the automatic machine soon runs low; without some bit of renewing of the brain force which was put into it, it soon ceases to be automatic, and without new thought it is a dead and worthless thing. It has never had the breath of life breathed into it. The poet and the preacher would have one believe, apparently, that it had brains, and that the poor fellow who is employed to see that the piece that fell from one tube entered the other tube properly, was brainless *because* the brains were in the machine; or if the fellow had any brains or thoughtfulness when put in charge of the monster, his brains must necessarily soon wither and die because there was nothing to keep them active. Oh, what a fallacy! And what great harm and injustice in such teaching! While it is a fact that persons nearly brainless may be found running automatic machines, the brains that the operative should have and which he ought to develop there are supplemented necessarily by the foreman or the inventor or the machinist. That is, automatic machinery and thoughtless and brainless operatives are sometimes found together; but, as some one has said, "because two things are found together it does not follow that one is the cause of the other."

The automatic machine, which is one element only in our system of intensified production, seems to be a provision by a kind Providence in the evolution of mankind for the poor fellow born without great ambition or capacity. It gives him a fair chance not only in the struggle for better life, but a fair chance for existence, even if he continue in his choice to look downward instead of upward—even if he stop his ears amidst a thousand voices crying about him in the myriads of groans and clatter of machinery: "Help us with your little thought, your little care, your little skill, your little love." When the storage battery of brains in the automatic machine runs low and weak, some part cries for a drop of oil to smooth its voice and cool its parched tongue; or because a screw or nut is loose, it kicks as frightened hoofs striking the dasher, threatening ruin and destruction; or it chokes with dust and smut. To all these cries of the machine the heedless operative, "the poor fellow who has no opportunity for the exercise of thought," as the preacher says, sits still and watches the machine all day long. He does not care to offer a drop of cool oil or to tighten the nut that would give quiet and peace to the destructive

kicking, or to brush away with a cloth the grime that brings stoppage and death. So the operative—"poor fellow," indeed, who thus flings away his chances—sits there and broods over the lack of opportunity that he has heard lying testimony about. The little dingy corner in which he sits all day long is one cloud of opportunity so thick about him that, were he alive to it, he could not breathe. He sits amid all the voices crying in his ear for helpful thought, simple, easy, growing thought, and does not choose life, but loses his soul.

The soul of a workman who loves his work grows all day long. How can a man love his work and lose his soul? A man that loves his work will love his wife and children, he will have a home, he will grow, grander opportunity will open before him and satisfaction and even happiness be his. If one loves his work and dwells upon it with careful thought and interest, he elevates himself and exalts his work. A man is seldom, if ever, degraded by his work, especially if it be mechanical work, or having to do with machines and tools. All machinery and all tools are most intimately related to evolution and suggest, more than anything else, the creative faculties of mankind.

Can a man be made to love his work? Yes, but he needs help sometimes and encouragement. Some men love their work naturally, as men love nature by force of their own natures. But more frequently men learn to love the fields, the woods, and animals because of the attractive teaching and preaching they listen to. Ruskin, by his charming manner, his skill and loving devotion as a teacher, taught eyes that were born blind to open and see a world filled with wondrous beauty. By such inspiration the heart learns to love, and the life grows. So our humbler workers who join the industrial ranks as operatives should not be led to look upon their lot with hopeless pity. Such doctrine is false. They should be taught the glad tidings of a glorious truth that comes in this new order of things. It is a gospel that says to every operator: "Come with us and learn to think—begin a career that is ever open at the top."

This is a system diametrically opposed to the British life, which was and is one of horizontal stratification. The American system is one of vertical circulation, and the force which suggests upward draft in all its functions and all its social and industrial life is the current of thought. Be it ever so faint, it is always upward. In this system let the poorest, the meanest of operatives think and act and help along the little lines running directly to himself, and all will soon recognize the upward draft and there will be vertical movement.

According to the idea of a modern writer, if you put ten boys into

the poorest factory in America and set them at the most commonplace work, in three days nine out of the ten will be asking the tenth boy where things are and what they shall do next. If you watch you will see that the tenth boy has been thinking a little, that he stops a little to arrange things after the bell strikes, that he gets in a little early and sees little changes to be made in the location of boxes, thoughtfully observes the oiler fix a hot-box, and gets a chance to hand him a wrench. That boy is all right. No one need say to him, "poor fellow, he runs one of those machines, he has nothing to think about." He finds enough to think about. The saddest fact about some workmen is that they will not choose to think, or, if they do think, it is about the wrong thing, about things that do not lead them to love their work.

The system we are considering always takes men of a lower order and places them under conditions new, different, and better than before. For example, wherever a machine operator is needed, a candidate is taken from a rank lower than a machine operator. In the rarest instances are workers taken from positions of higher grade and degraded to the simpler task of tending a machine. For illustration, go into the great factories producing wearing apparel. The sewing machine running at lightning speed is not operated by those who have before been skilful in needle-work. Go into a machine shop where the parts of high-grade machinery, such as screws, shafts, and wheels are produced by automatic milling machines, lathes and grinding machinery, and it will be found that the operators of these machines are never men who have been degraded from the ranks of skilful machinists. But the operator is a new species of workman, evolved and advanced from a lower class of skill or from a class that has heretofore had no opportunity to develop skill.

If we wish to develop a thinking people we must first make a working people. Through the cunning of the hand, the mind is called upon to act. Thus our factories, if properly organized, may be and generally will be, as is now sometimes true, incubators, and breeders of men of higher character and happier lives.

The operators of automatic machines, whose failure to grasp opportunities for lack of helpful teaching has been the cause of a condemnation of our industrial system, are persons who have never had an opportunity to exercise thoughtfulness at all. If they could be put in any position on earth where more thought and more responsibility were required, failure would surely follow; not only failure to get anything accomplished in the duties of the position, but failure to accomplish anything in the way of developing the individual; and

this is simply because too much is undertaken at first. The ideal condition for such human nature is a place very easy to enter at the bottom and open at the top for all advancement in activity of thought, but where the continuance of opportunity is not jeopardized or the individual disheartened, even if mental activity and general advancement are very slow or even reduced nearly to zero. It is at such a point that proper teaching and education are needed, and it is this grand opportunity which America should recognize.

Imagine a workman engaged on the most monotonous occupation that is talked about, where he has nothing at all to do but see that a piece falls out of one tube and enters another. There are really no such men employed. The field of duty is always broader than that, and the responsibility is generally as great as the individual can properly assume. But suppose there is such an extreme case as an operative engaged upon such a machine. Suppose then he is able and willing to do some profitable thinking, and instead of assuming that his chances are hopeless, let him be taught, let him see that this machine is one of the greatest accomplishments of the greatest faculty of mankind, *the creative power*. To secure the best results, and to evolve all that may be possible from this machine in its present condition, the operative must comprehend all its functions, its weaknesses and its possibilities, its temptations and its dangers. It is so made that it will go on very well for a while if he simply feed in the material and remove its product. Thus he is enabled to enter and be introduced to a great world of thought and action, and to be received cordially into this realm of mechanical industry without a technical training or much skill of hand. The conditions for entrance are very low, but his career is open at the top and his field of thought and self-improvement is unlimited. Let him see that there is infinite beauty in every mechanical movement and wonderful interest in every function, that its conception, comprehension, and perfection is the highest work of man, and that the shaping of a perfect screw-head or the production of a faultless pin-point is a thing of beauty and a source of enjoyment. Show him the infinite relation of his personal daily toil and duty to all the other great and beautiful things of the outer life of the universe. This is all possible so far as our industrial system is concerned. The capacity of the workman is our only limitation—and what other system can possibly reach down so low and so kindly? If this be true, how can we say that our system is degrading or oppressive upon the masses of workmen because each one must be a specialist and do his particular work better than any other? Add

to this other facts whereby his social relations and opportunities are immeasurably better than the working man has obtained since the beginning of history. His hours of labor are reduced already to a limit below almost any expectation. This is made possible only through intensified production, the system of machinery and division of labor, piece work, etc. By this the American workman has time for home, family, social enjoyment, and self improvement far beyond that of any other age or system; and better things are coming fast to him who waits and works patiently and actively in sympathy with the great all-powerful and inevitable system.

It still remains to show another line of benefit of even wider importance than any other, viz., the effect of the system upon the people's education.

Notwithstanding the just pride in American popular education which exists in the United States, the fact still remains that all education, except the most elementary grades, affects only the few, say one in one hundred. The ninety and nine unaffected by higher education are our people, and they constitute our great national force and power. America is not likely to suffer when its engineers are compared with those of any other nation. American universities have now arrived at a stage that renders it unnecessary for us to send our sons away for the best training in science and engineering. But our technical schools are year by year devoted more and more to the education of the scientist and the professional engineer, while the field, no less important, for the technical training of our skilled workmen, is still left as uncultivated as ever. The best and fittest education of our working people is of the highest importance, and the neglect of it the greatest danger to the supremacy of American industry. Trades schools, skill teaching, is the one great opportunity America should realize and grasp.

Our industrial system tends directly to give more time and leisure hours for education of the workers. It so emancipates the worker from excessive fatigue of both mind and body that the first condition of education is met. This system not only opens the way to the attainment of technical knowledge through time for thought and study, but opens the way to a culture which is, in fact, more than half of the benefit of what is termed a liberal education.

Culture is the one thing above all others that the American mechanic needs to exalt his most noble calling and advance his standing among men. Culture, rather than learning, is that which sets the university man on high. It comes largely through contact with better

men and with good men of all grades. The intense industrial system brings every grade of worker into respectable contact with his superiors, and he associates with all grades of men.

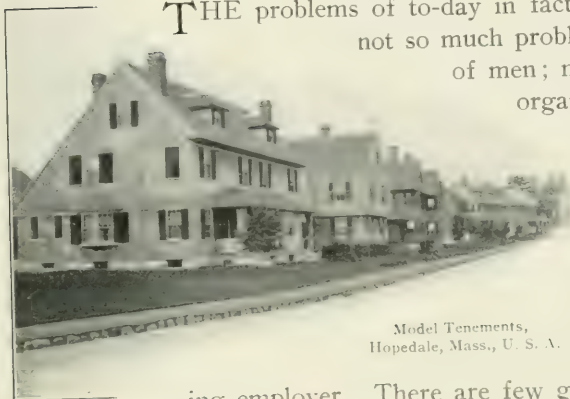
We read much that is said of the benefits lost when the old apprenticeship system passed away. We must remember that, though the apprentice enjoyed a home-life with the one master, it was, nevertheless, a narrow life, and a life confined to rigid limits. Now, the mechanic who enters the ranks at the lowest or simplest stage, that of a machine tender, is immediately brought into contact with a master who is selected for his ability and superiority as a workman and as a director. In the true sense the humblest worker is now an apprentice to trades broader and more varied than ever before. He associates and competes with many co-workers; he is usually well treated and favorably considered by all the force of better educated men.

The benefits of this system can hardly be overstated. Contact with others and with superiors is the main source of culture, and when the American mechanic adds culture to his skill and technical training, he will stand among the favored ones of earth, and his influence will be broad, good, and mighty among men.

We have been blinded and confused in our faith and confidence in a great and emancipatory principle, which underlies and involves this system of intense production, because of some previous evils which have existed in spite of all the good that is likely to flow from the very system which is falsely condemned as the cause of the supposed evils. The system does not produce the evils which some trade unionists think. The system has within it the elimination of the evils. And this elimination will soon take place if proprietors and workers of all grades join in the inevitable recognition that the system is the new dispensation which makes for the greatest good to all workers, elevating each and everyone according to his personal and individual merit. The great industrial redemption is sure to come through this very system. The greatest hindrance comes from the false belief that there is an element in the system tending to crush and oppress the humbler worker, and that systemized and concentrated industrial factories, with automatic machines and tools, with just systems of piece work and of division of labor, etc., are in any way opposed to the betterment of every worker. It is unjust, unfair, and unnecessary to attempt to put all workers upon a dead level by dragging the better down. Instead we should hold to all that is high and good, and reach out a hand to bring up the lower.

ALTRUISM AND SYMPATHY AS FACTORS IN WORKS ADMINISTRATION.

By John H. Patterson.



Model Tenements,
Hopedale, Mass., U. S. A.

THE problems of to-day in factory management are not so much problems of machinery as of men; not so much those of organization as of personal relations.

How best to develop the principles which are necessary for the solutions of these problems is the question with every think-

ing employer. There are few great companies in the world with organizations as complete or plants as well equipped as those of the great manufacturing establishments of the United States, and American manufacturers are anxious to retain their position of priority in the world. The one problem whose solution will assure permanence in the new commercial life of the nation is the adjustment of relations between employer and employee on a fair and humane basis. If American manufacturers and their workmen unite in enthusiastic development of one another's interests, they will retain their leadership.

The introduction of steam power into the manufacturing world drove the little blacksmith shop, shoe shop, the country dairy and weaver's loom, from the village into the city and opened many new problems. In those early days, the small workman found it best to consider carefully the physical, moral, and mental welfare of his apprentice and his assistant. If it paid the small employer to do this, it

A tour of the machine shops of the United States and the newer works of Europe gives few impressions more striking than the one created by the widespread evidence of growing thought for the comfort of the workman. Humanitarian considerations aside, it pays—pays in quality and in lowered cost of output—when the worker is kept well nourished and in good hygienic surroundings. It is not, of course, possible for all works to go so far as some of Mr. Patterson's examples indicate, but the general principles are everywhere applicable and for this reason the many actual instances shown are of universal value.—THE EDITORS.

will pay the great employer many-fold more to have the same thoughtfulness for the hundreds or thousands in his employ.

The difficulty will be to determine what is needed for this adjustment, and how to accomplish the arrangement even with the needs recognized. It would seem, however, that all will agree that among the essentials to economic production and a proper adjustment of relations are opportunity for thorough training of the workman, and his co-operation in saving and in perfect manufacture.

Some employers have sought to win this sympathy and assistance by large gifts to libraries, museums, and other public institutions open to working men. Others have aimed at it by a system of profit sharing, and still others, in increasing numbers, have sought it by introducing special features into their factories and by opening unusual opportunities to their people. This latter plan has as its foundation principles the ideas that an evidence of daily thoughtfulness

will be surest to bring assistance and response; that a recognition of the laborer as a man with human aspirations, often with keen sensibilities and with



FEATURES OF THE ALTRUISTIC POLICY OF WORKS MANAGEMENT BY LEVER BROS.,
AT PORT SUNLIGHT, ENGLAND.

Village schools and school children. The interior of a class-room is seen in the upper corner illustration.



VILLAGE BOWLING GREEN AND
MEN'S SOCIAL CLUB. PORT
SUNLIGHT.

love of home and comfort, will find a responsive chord within; and that poverty, lack of education, and narrow views are not necessarily evidence of a lower form of life.



THE GIRLS' INSTITUTE. PORT SUNLIGHT

It is with this in mind that a large number of employers are seeking to adapt their factories and methods to the needs of to-day. The personal experience of the writer and of others who are seeking by similar methods the same results, may not be out of place in this magazine. These are given as illustrations of what may be accomplished, and how it may be done, rather than as statements of relations to be closely followed. Thoughtful men to-day want not so much theories as facts. Hence, experience and actual work of the shop will be more acceptable than a discussion of what ought to be done.

It is difficult to understand why so much carelessness exists regarding the condition and ventilation of the average shop. The very first essential to the solution of the humane elements in the machine-shop problem is clean and well-ventilated buildings. It is often assumed that this is possible only for certain forms of light and clean manu-

facturing, but experience has proved that even in heavy machine shops, rolling mills, woolen mills, and paper mills, cleanliness and good ventilation are possible. The expense of accomplishing this is so small as compared with the increased output resulting from it, that one wonders that any company ever hesitates to accomplish these things. It does not require much force or a great expenditure of money to have clean floors and windows and to furnish fresh air. In addition to this, good drinking water, comfortable toilet rooms, and proper heating, will assure health and, therefore, better work. The National Cash Register Company's experience in this matter is constant proof of the value of bright and cheerful surroundings as well as of perfect cleanliness. Its buildings six years ago were completely remodeled and renovated, and from that time to this cleanliness, good ventilation and proper heating, have been emphasized with remark-



DINING ROOM FOR EMPLOYEES, CLEVELAND HARDWARE COMPANY'S WORKS.

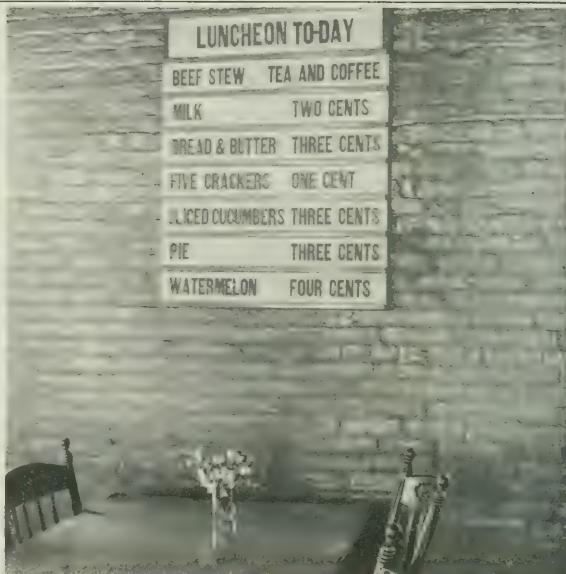
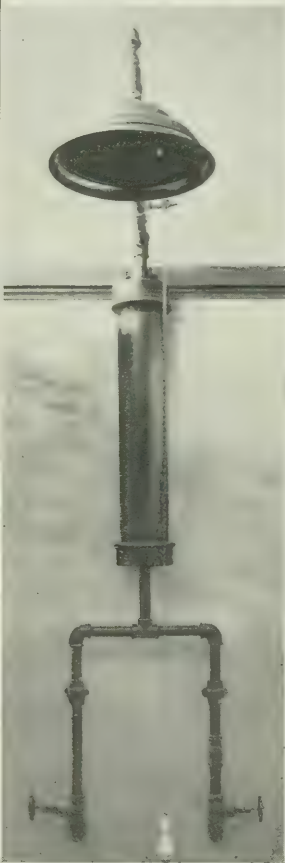
able success. The Sherwin-Williams Co., of Cleveland, in its paint mill, and the Cleveland Hardware Co., in their rolling mill, have shown what can be done when proper inclination exists. In England are a number of very notable examples of the value of beautifying factory grounds and employees' cottages. The most prominent of these are the Lever Bros.' soap works, at Port Sunlight, and the Cadbury cocoa works, at Bourneville.

Attention to personal comfort is another of the essentials in the



SOME SPECIAL INSTITUTIONS OF THE CLEVELAND HARDWARE COMPANY, CLEVELAND, OHIO, U. S. A.

The lower picture shows workmen lining up for the lunch furnished at trifling cost. The upper ones illustrate the girls' rest room and the library.



PROVISIONS FOR WORKMEN'S COMFORT AND HEALTH MADE BY THE SHERWIN-WILLIAMS COMPANY, CLEVELAND, OHIO, U. S. A.

On the left are seen the lavatory arrangements—the upper picture shows also the men's lockers. The lower picture on the right illustrates one of the rest rooms; in the cut above is shown a lunch bill of fare, changed daily.



TWO LUNCH ROOMS, THE SHERWIN-WILLIAMS CO., CLEVELAND, OHIO, U. S. A.
The employee's own lunch is supplemented by hot dishes, tea, coffee, etc., served at exact cost, with no charge for service. Reading and recreation facilities, washrooms, laundry, etc., are also provided.

recognition of the needs of employees. By this is meant thoughtfulness for comfort in work—proper arrangement for lunches and food—opportunities for rest, for baths, and for all those things which add strength and encourage contentment. When our company began its present system, it first provided stools with backs and foot rests for its em-

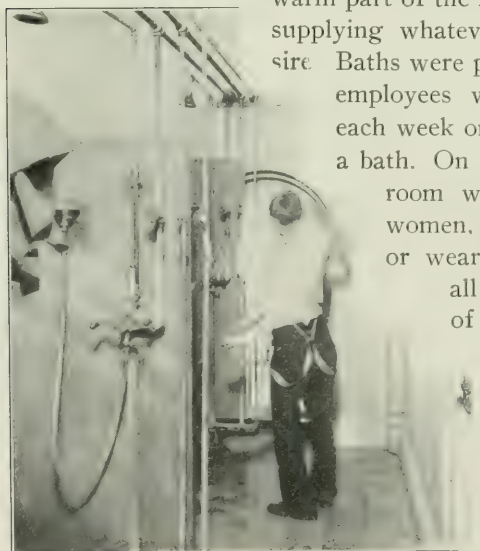
ployees. Then arrangements were made for the women of the factory to ride up and down on the elevators, if they chose, instead of climbing the stairways. Ten-minute recesses were given to the women in the morning and afternoon, affording them opportunity for relaxation. A large dining room was provided, in which a wholesome lunch is served each day at noon to two hundred and fifty or more of the young women employees of the company, the company furnishing the

warm part of the lunch, and the young women supplying whatever additional they may desire. Baths were provided in all buildings, and employees were given twenty minutes each week on the company's time to take a bath. On one of the floors, a neat rest room was provided for the young women, for use in case of sickness or weariness. Cots are supplied in all the buildings for use in case of accident. Other companies

have carried out many of these same ideas, some by fitting up rooms in their own factory buildings—as in the case of the T. B. Laycock Mfg. Co., of Indianapolis, and the Acme White Lead Co., of De-



THE GORHAM CASINO. MAIN DINING HALL SET FOR A BANQUET TO THE HEADS OF DEPARTMENTS.



MEN'S BATH ROOM, NATIONAL CASH REGISTER CO.



YOUNG WOMEN'S LUNCH AND REST ROOM, T. B. LAYCOCK MFG CO.,
INDIANAPOLIS, IND., U. S. A.

Coffee, tea, cream, and sugar are supplied at the expense of the company. After lunch the employees may spend the time reading or playing the piano.

troit—while others have provided and equipped club houses adjacent to the factory with the conveniences of lunches, baths, and reading rooms, open freely to all employees. The Gorham Manufacturing Company, the Joliet Steel Works, and the Eagle & Phoenix Company are illustrations of this idea in the treatment of employees.

It is not sufficient, however, to think simply of the physical wants. To accomplish one of the great aims of all such plans—that of securing intelligent operatives—it is necessary to afford the work people opportunities for mental training and mental growth. This idea when first advanced was combated in many cases, but employers generally are now agreed that skill and intelligence are essential to the highest accomplishment. Our first

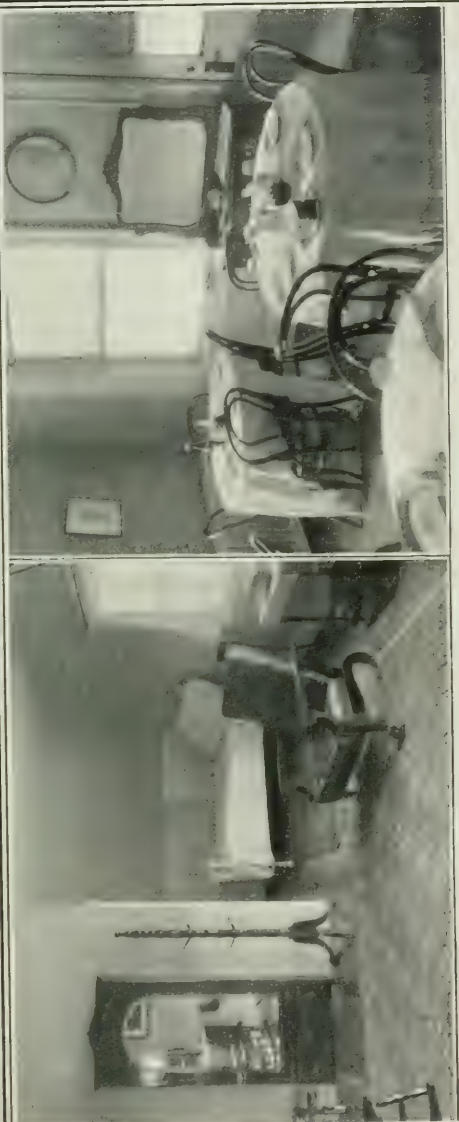


THE GORHAM COMPANY'S CASINO. A BEDROOM.

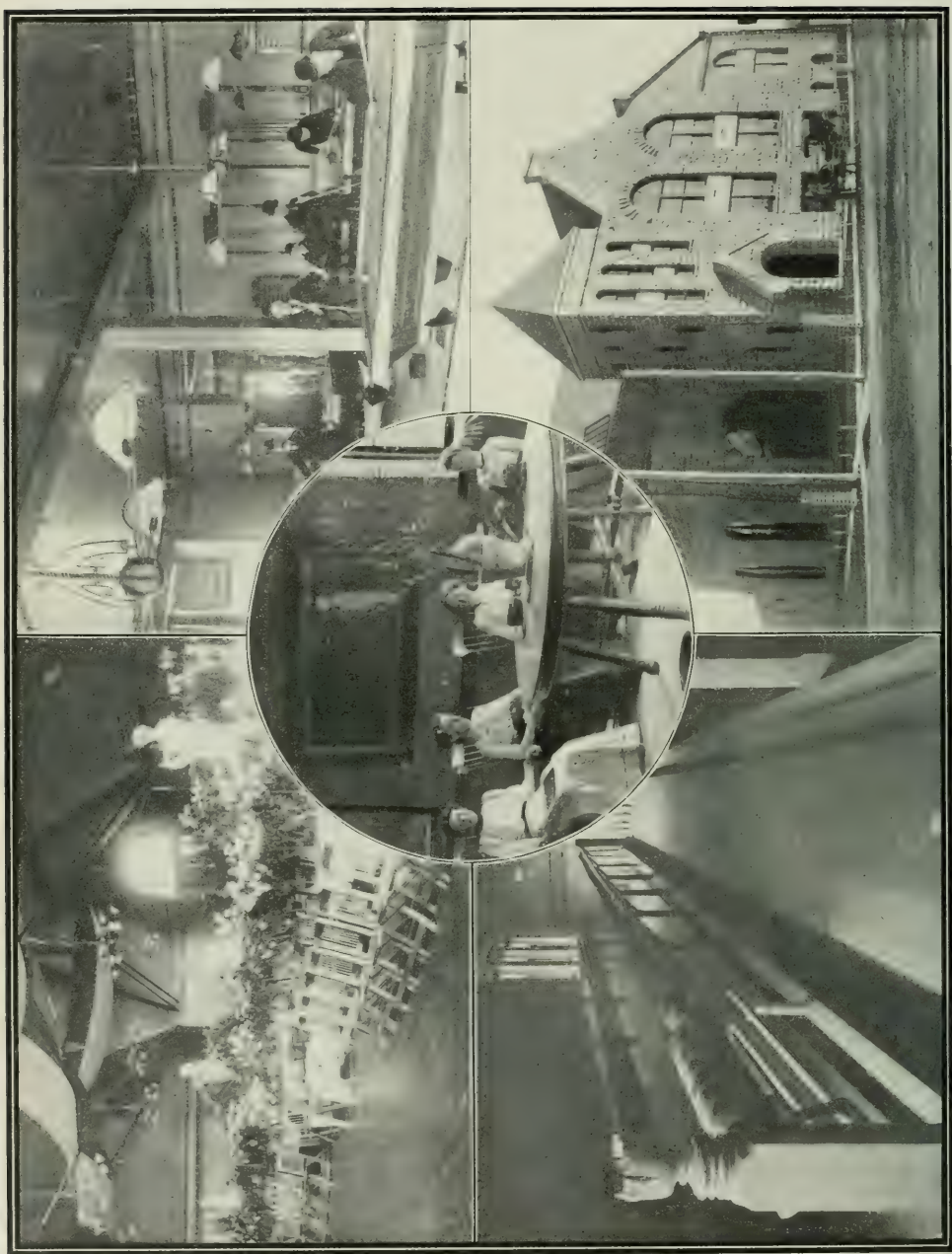


CHARACTERISTIC INSTITUTIONS OF THE ACME WHITE LEAD WORKS, DETROIT, MICH.,
U. S. A.

A.—A lecture on the Chemistry of Paints. B.—Preparing coffee for employees. C.—Lunch
for the office force.



THE CASINO OF THE GORHAM COMPANY, PROVIDENCE, R. I., U. S. A., WOMEN'S DINING ROOM AND A SLEEPING ROOM. The efforts of the company to advance the comfort, education, and recreation of the workmen centre in this institution. The main object is to enable the men to enjoy their midday meal. The main dining hall is used also for concerts and social entertainments. On one side of it is a library and reading room, and on the other a private dining room and a women's dining room. In winter the ample piazzas are enclosed by glass sash.



FEATURES OF LABOR MANAGEMENT AT THE JOLIET STEEL WORKS, JOLIET, ILL., U. S. A.

The characteristic institution is the Steel Works Club, which comprehends many social, educational, recreative, and benevolent features. The club house is shown in the lower right hand corner. Above is the billiard room. On the left are the auditorium, taken during a flower show, and the bowling alley. The center view shows a woman's club meeting.

step in carrying out this idea was to give the fullest information to everyone regarding the company's work and business. This was accomplished by frequent meetings of a part or all of the employees, by conventions, by publications, and by announcements. A club consisting of the heads of departments and their assistants was formed, meeting frequently on the company's time in a large hall of the main building, provided for the purpose, with the object of discussing important topics relating to the general business and of receiving suggestions and complaints from the departments. Realizing that many of the employees



MAIN DINING ROOM IN THE GORHAM CASINO.

The men are invited to bring their own lunches, and can add tea, coffee, milk, etc., supplied by the company at absolute cost.

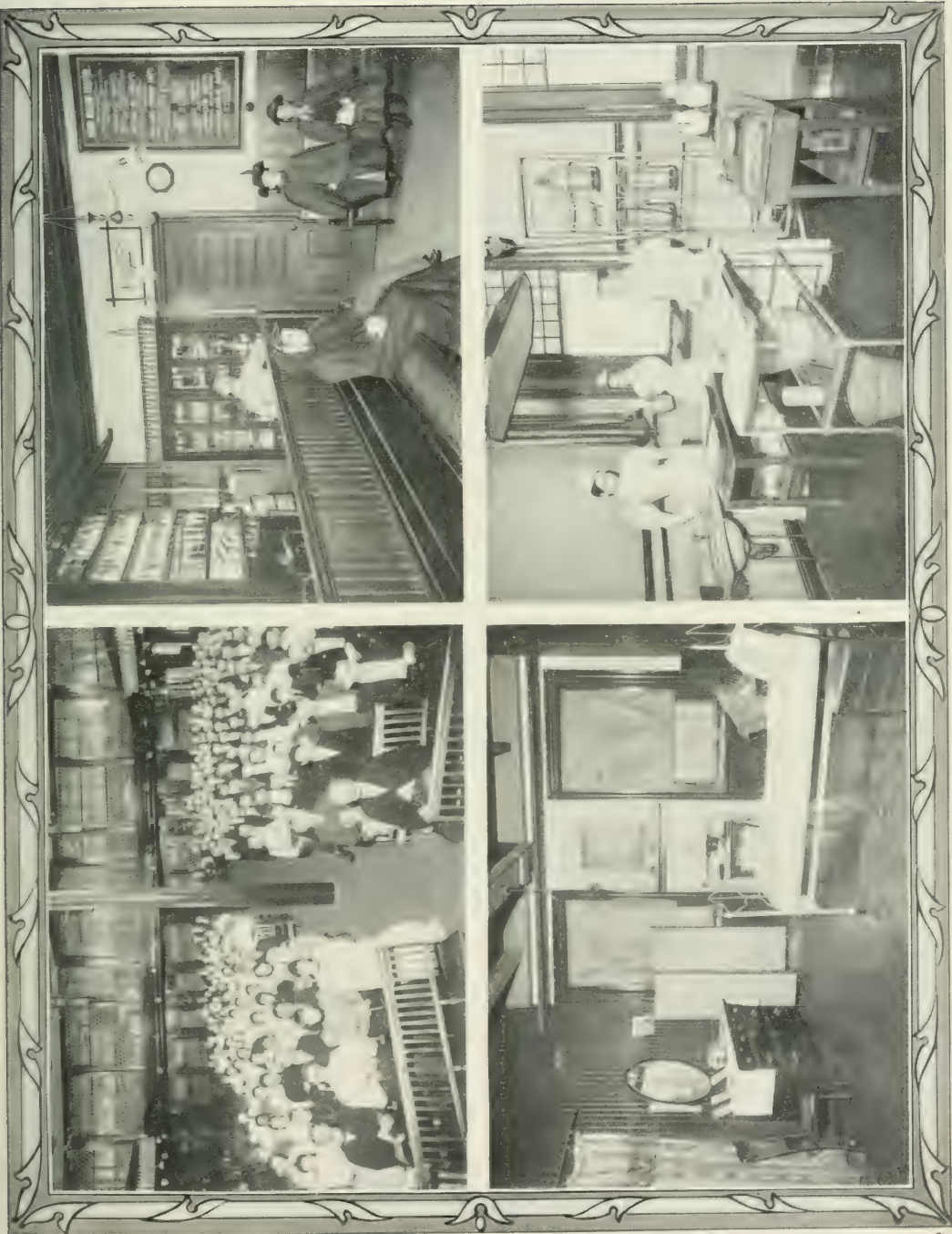
needed instruction in simple mechanics, general meetings were held, where, by special entertainments, made interesting by the use of stereopticon pictures, instruction was given in the simplest elements of mathematics and mechanics. By these methods the company succeeded in proving to its employees that its motives were for their highest good and, step by step, their attitude changed from one of indifference and opposition to one of enthusiastic support. Other companies, like the John B. Stetson Company, of Philadelphia, have found these

same ideas practical and have carried them out, adapting them to their own particular needs. The Cleveland Window Glass Company, the Acme White Lead & Color Works, and other companies have well-organized classes for instruction in special subjects.



THE BAND. AN EMPLOYEES' ORGANIZATION IN THE JOLIET STEEL WORKS.

One of the most thoughtful methods in the development of sympathy has been the system of prizes for suggestions, which has resulted in leading everyone to seek to assist and to give his best thought. This is accomplished usually by placing in the various departments an autographic register or a small box, upon which one may write his suggestion, or in which he may place the idea or complaint which he desires to present. Each man and woman is encouraged to think independently, and to watch for improvement in his own work and that of others. Series of prizes are offered, ranging usually from \$10 to \$50 each, covering a period varying in different companies from one month to six months. These prizes are usually open to all except heads of departments and assistants. As suggestions are received, they are carefully examined by one appointed for this purpose and when practicable, are put to good use and proper credit given. The



HUMANITARIAN FEATURES OF THE LABOR POLICY OF THE JOHN B. STETSON COMPANY, PHILADELPHIA, PA., U. S. A.
The Assembly Hall, Dispensary, and Hospital.

occasion of the presentation in most of these factories is one of great interest and enthusiasm. In the practice of our own establishment it is always made an opportunity for bringing together the employees and their families. During the summer it becomes an out-of-doors gathering, at which thousands of employees and their families gather for pleasure and profit. This cultivates an *esprit de corps* which is

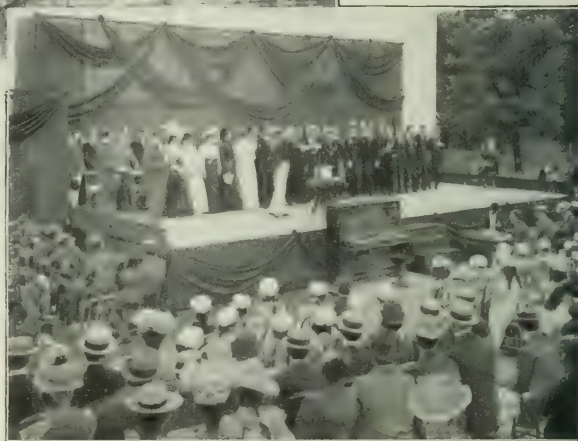


felt throughout the entire factory. This company receives about 2,500 suggestions a year, a large portion of which may be put into actual practice. This same idea is

becoming very popular among employers, the experience of the Eastman Kodak Company, Bausch & Lomb, and others proving in the highest degree satisfactory.

This encouragement to think for the interests of the company

finds its expression very frequently on the part of employees in organization of clubs among the workers themselves. In this company, there are the Women's Century Club and the Men's Progress Club, meeting twice each month, with regular programs and carefully-wrought schemes of work. Relief-association organizations, for systematic assistance in case of sickness, are popular in many companies. Organizations for recreation or study are sure to be formed when a community feeling has been carefully developed among employees.



AT THE NATIONAL CASH REGISTER WORKS.

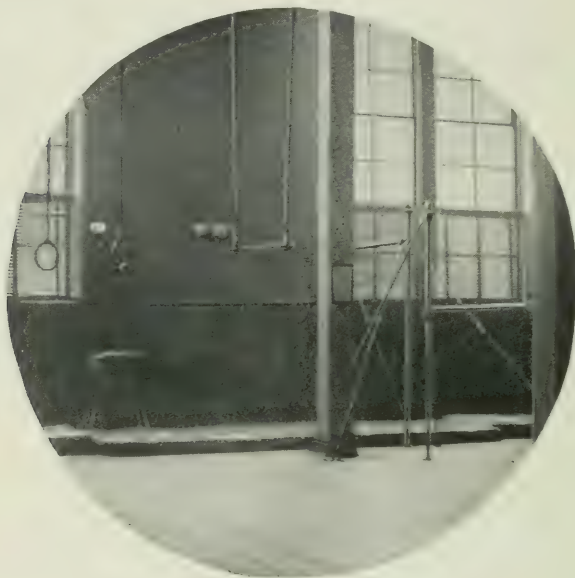
Prize trip of foundrymen to Cincinnati, and prize distribution at one of the annual festal occasions.



VIEWS ILLUSTRATIVE OF THE ALTRUISTIC POLICY AS CARRIED OUT BY THE NATIONAL CASH REGISTER CO., DAYTON, OHIO, U. S. A.

Below on the left is a photograph taken while lunch was being served to men obliged to work overtime; above is the assembly hall during an address to the women employees' Century Club; on the right are three engravings showing the lavatory, lunch room, and circulating library.

To assist in thus cultivating thoughtfulness, a factory library and reading room are valuable. It has been found that city libraries are always ready to co-operate in the development of this idea to the full extent of their ability. Stereopticon lectures, on all questions which will lead men to think, are very helpful and popular. It adds some-



JOLIET STEEL WORKS. THE GYMNASIUM

thing to the intelligent work of the employee to know something of the country into which his product is to go. Therefore, practical talks on England, Germany, and other countries of the world, all assist in leading to thoughtful action in connection with the work. Quotations from good literature and suggestions on practical subjects, hanging in various places in the factory, all increase this thoughtfulness of the employee.

The duty of the employer in this problem is not completely fulfilled if he confines his efforts solely to his employees. Too often, the coming of a factory into a neighborhood is considered a misfortune, and has a depressing influence upon the value of residence property within its vicinity. This is not necessary and, with a little effort on the part of the factory people, it may be avoided. The factory may be made a center of life and influence for the entire neighborhood. A club house or settlement house immediately adjoining the factory premises, with

qualified men or women in charge, will rapidly become a center of social, educational, and moral influence for the entire community. The "N. C. R. House" at Dayton is a little cottage in charge of a deaconess who gives her entire time to the needs of the community, and contains a library and reading room open to the neighborhood, a kindergarten for the children of employees and the neighborhood, and a room for the meetings of numerous clubs organized among the boys, girls, young people, and men and women of South Park. In addition to this, prizes are offered amounting to \$300 a year, for the improvements in homes, yards, and surroundings. This includes plant-

ing in front yards, back yards, the cultivation of vines, window boxes, vacant lots, boys' vegetable gardens, and similar things which



will add to the beauty and comfort of the neighborhood. So successful has this plan been in this case that the street facing the factory is regarded as one of the most beautiful



PRIZE GARDENS, EMPLOYEES OF CLEVELAND CLIFFS IRON CO., ISHPEMING, MICH., U. S. A.

working-men's streets in the world. The company in this case has set an example by beautifying its own grounds and surroundings in every way possible, seeking to accomplish the desired result by following the simple rules of good landscape gardening, and by the use of such shrubs only as the people themselves may cultivate if they desire. This idea is not wholly confined to this one company, though it has not been followed very extensively in the United States, outside of some of the older New



FACTORY EMBELLISHMENT. A CORNER IN THE CADBURY WORKS, BOURNEVILLE, ENGLAND.

England factory towns. The most prominent examples, perhaps, are in England, including those of the Lever Brothers' Company, of Port Sunlight, and Cadbury Brothers, at Bourneville. The Draper Company, at Hopedale, Mass., and the Cleveland Cliffs Iron Company, at

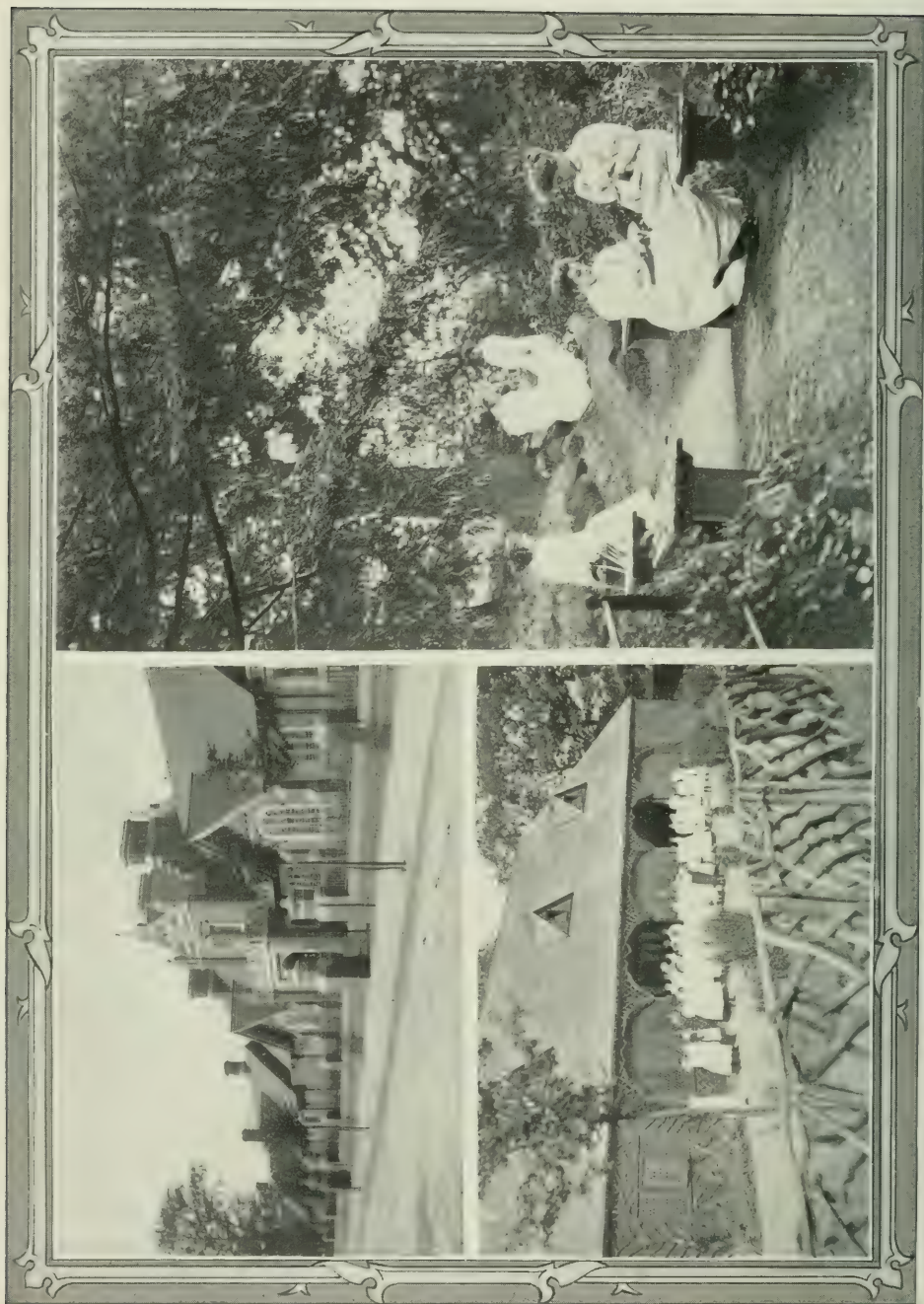


THE VILLAGE POST OFFICE, PORT SUNLIGHT



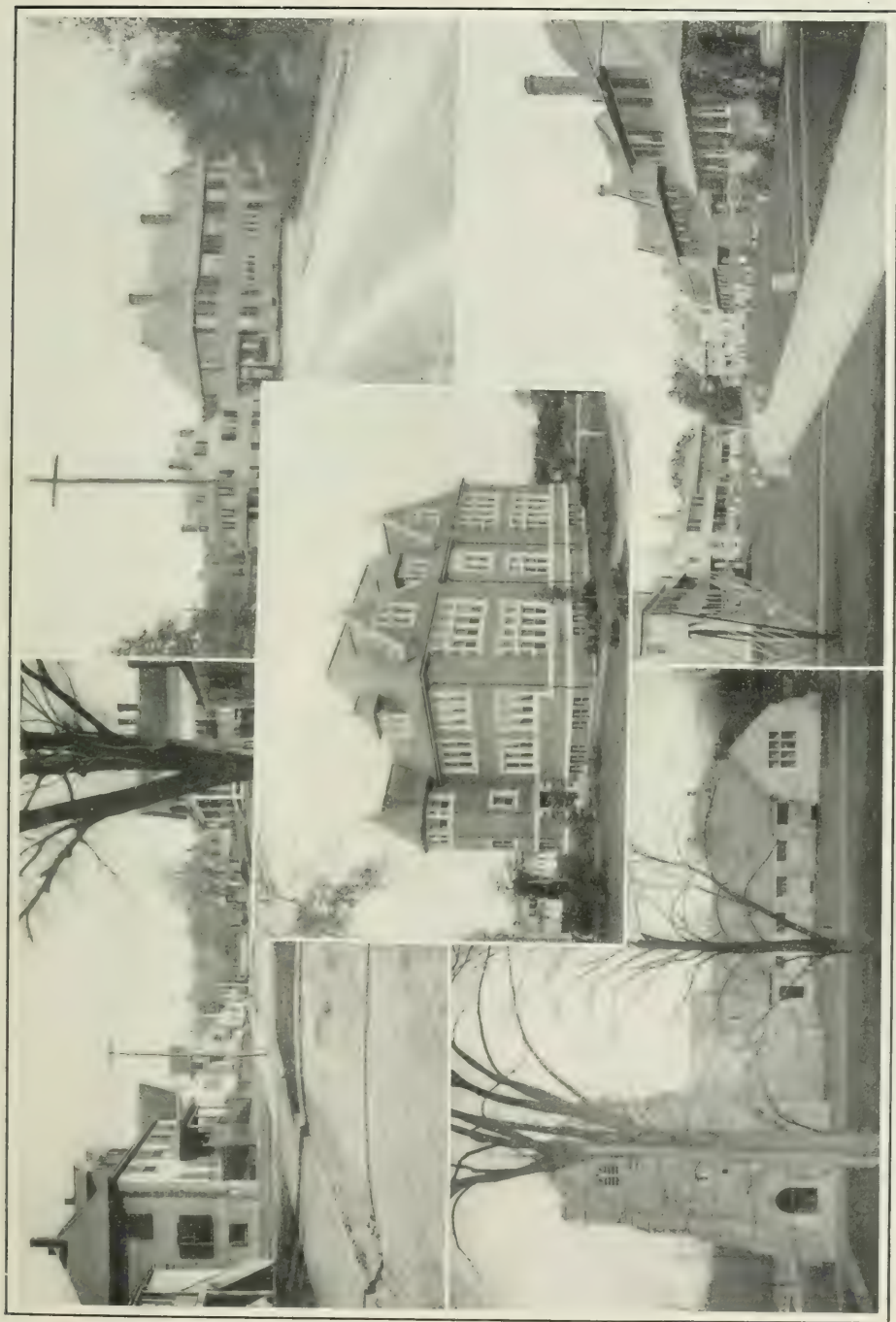
CLEVELAND CLIFFS IRON COMPANY, ISHPeming, MICH., U. S. A. GENERAL OFFICE
AND WORKMEN'S GARDENS.

The company stimulates neatness and thrift by offering prizes for the best-kept grounds and gardens. The illustrations are taken from the prize-winning homes of 1899.



AT THE CADBURY COMPANY'S WORKS, BOURNEVILLE. AGENCIES FOR THE CARE OF OLD AND YOUNG.

On the left are the almshouses and the pavilion on the girls' recreation ground. On the right are girl employees resting after the day's work.



CHARACTERISTIC FEATURES OF THE LABOR POLICY OF THE DRAPER COMPANY, HOPEDALE, MASS., U. S. A.

The town is built up in connection with the works. In the center of the group above is the grammar school; in the lower left corner is the memorial church. The remaining three views show portions of the model settlement of tenement houses which forms an important part of the company's system.

Ishpeming, Mich., are further illustrations of this idea of neighborhood improvement and the use of prizes for good planting.

Mr. Law's Briar Cliff farms, in New York, are an illustration of what may be done toward helping workmen in their lives. His idea of kindness to men and animals is expressed in the mural declarations in the homes which he has erected on these farms for his unmarried employees:

"Speak gently—it is better far
To rule by love than fear."

Going one step further in the recognition of this responsibility toward the neighborhood is the establishment of kindergartens, manual training schools, "pleasant Sunday afternoons," and other organizations under the encouragement of the company and its officers. This company has, for a number of years, supported a kindergarten open to the children of employees and of the neighborhood. It has a domestic-economy department, with cooking and sewing lessons for the girls of South Park and the young women of the factory. It has a boys' brigade and various boys' clubs for the lads, who are enthusiastic in their co-operation in all the plans that are made and who, with increasing care, assist in keeping the grounds of the neighborhood in a beautiful condition. A penny provident association offers opportunity for saving. A women's guild enlists the mothers for the best interests to their homes and their children. A choral society attracts the young people, while the "pleasant Sunday afternoon," or "Sunday school," as it is often called, furnishes an hour or an hour and a half of helpful interest each Sunday afternoon. This is intended not for teaching religious truth so much as for giving practical instruction in the true ideas of moral life. Two features of this plan will always give good results. One is the encouragement of the reading of the children by offering prizes to those who read and bring quotations from their reading each Sunday. The other is the use of the stereopticon for one-half hour at each gathering, with lessons in practical things that will be a help in the home life.

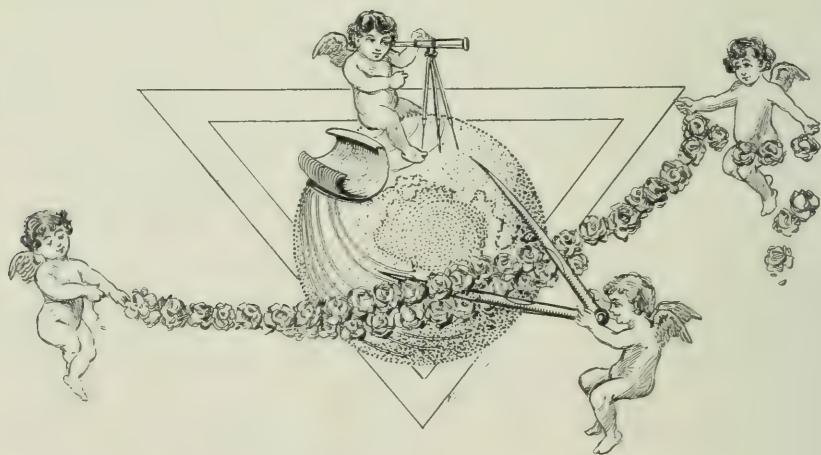


THE MEMORIAL TOWN HALL, HOPEDALE, MASS.

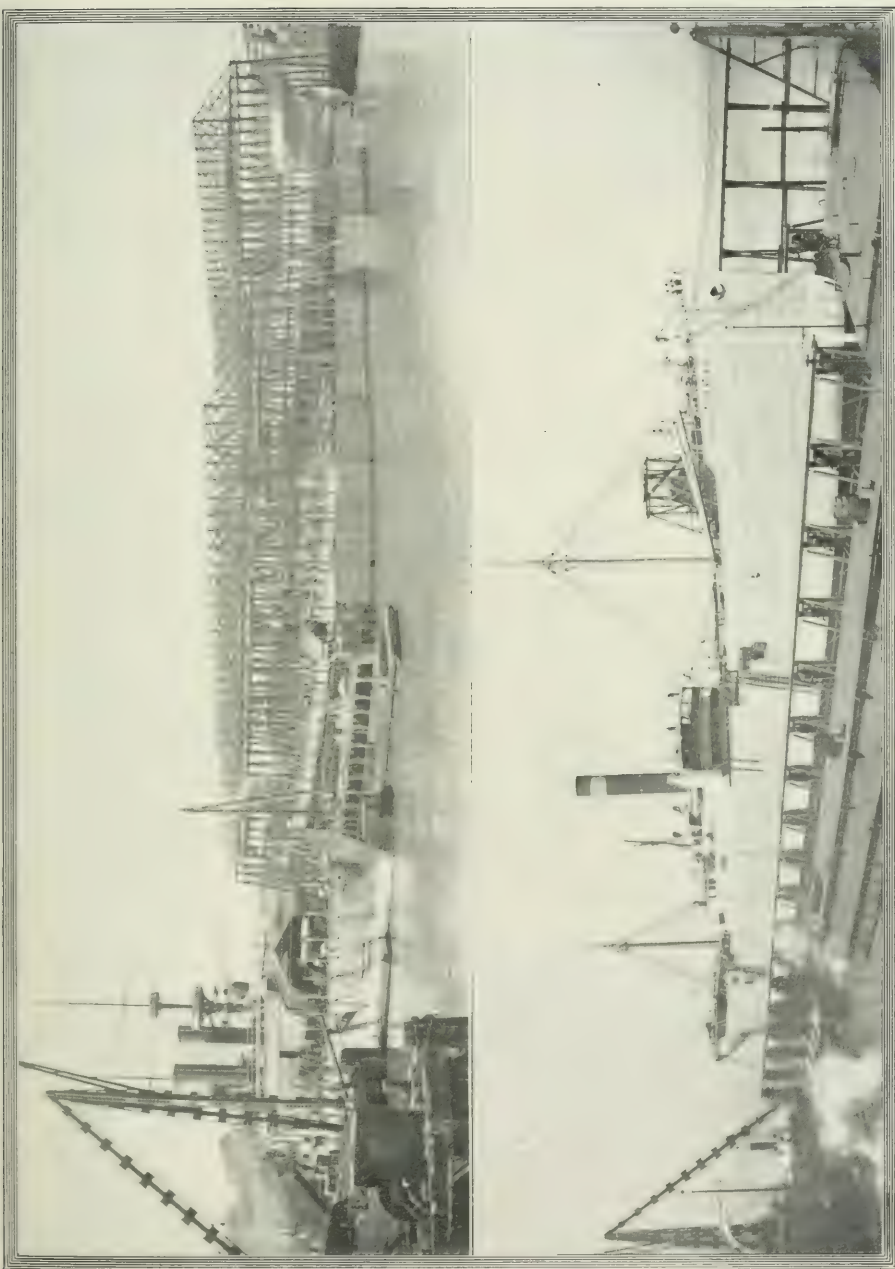


CHILDREN'S PLAYGROUND AND NOONDAY RESTING PLACE FOR EMPLOYEES,
CADBURY WORKS, BOURNEVILLE, ENGLAND.

Such, in brief, is a suggestion for practical methods of influencing the assisting employees and the neighborhood, and thus solving the personal problem of modern manufacturing. The suggestions here made have not covered all that may be done, but are those which have been found practical helps in one or more factories of the United States. These efforts have been recognized as helpful not only by employees, but by the leaders of labor, religious, and social organizations. The kindly spirit which they indicate is reciprocated, both at home and abroad. The plan has been studied by prominent men and women and commended by students in many lands. The opinions of public men who have studied these efforts encourage their continuance as being the surest method of solving this problem. Carefully-compiled statistics show that they will help to reduce the cost of production, and the system indicates a growing improvement in the character of the working people and in the increasing advantages, both to the company and to its force. Because these things require little change from the usual methods, they are practicable under existing conditions, and because of their broad helpfulness, they must prove valuable to all classes of the community.

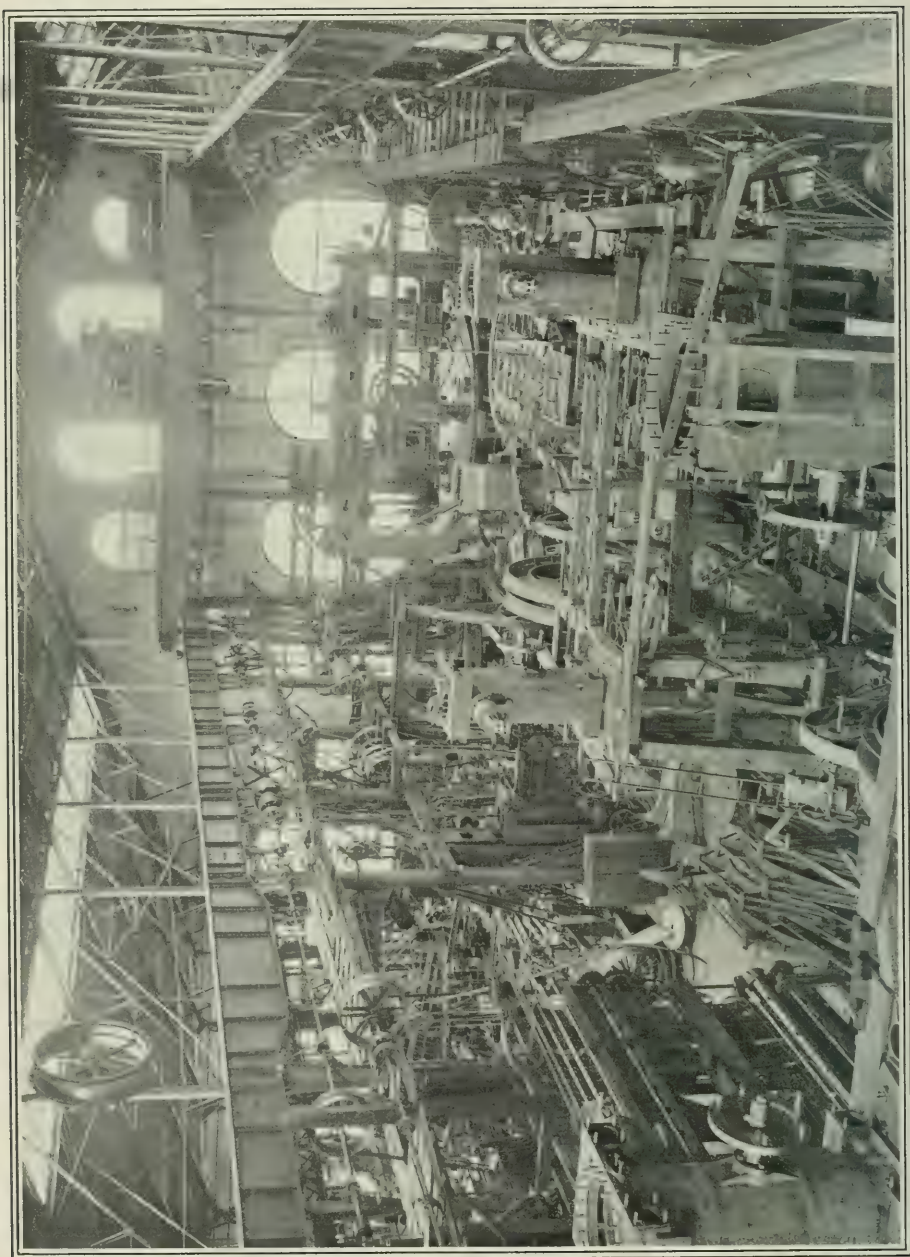


GREAT WORKSHOPS OF THE WORLD.

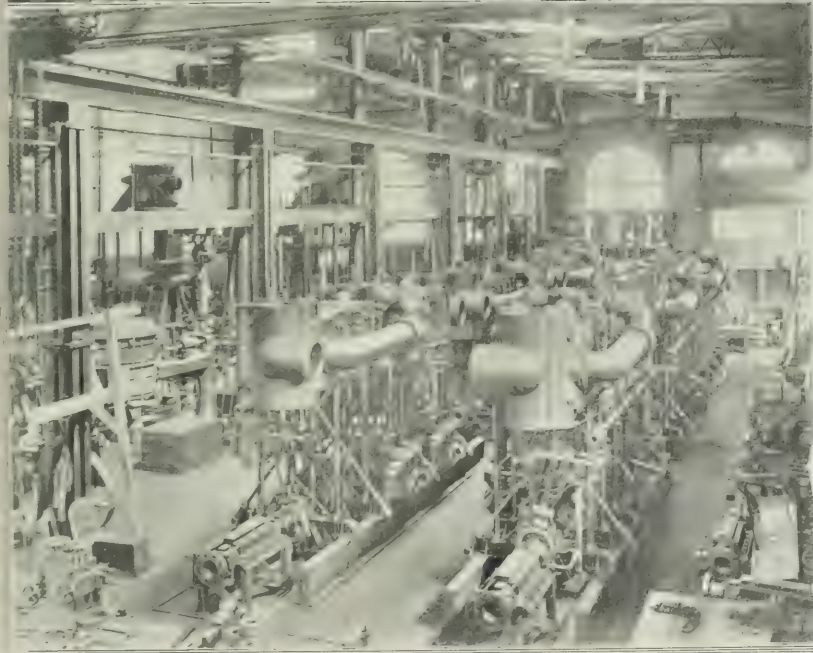


VIEWS IN THE UNION IRON WORKS, SAN FRANCISCO, CAL., U. S. A. THE BUILDERS OF THE U. S. S. OREGON.

The upper view shows the general water front. In the distance are the boiler shops; in front of them the U. S. S. Wisconsin at the 100-ton shear legs. On the stocks are the torpedo boats Paul Jones, Perry, and Preble, the monitor Wyoming, battle-ship Ohio, and freight steamer Californian, 8,000 tons' cargo capacity. Below is the hydraulic dry-dock with a vessel lifted upon it.

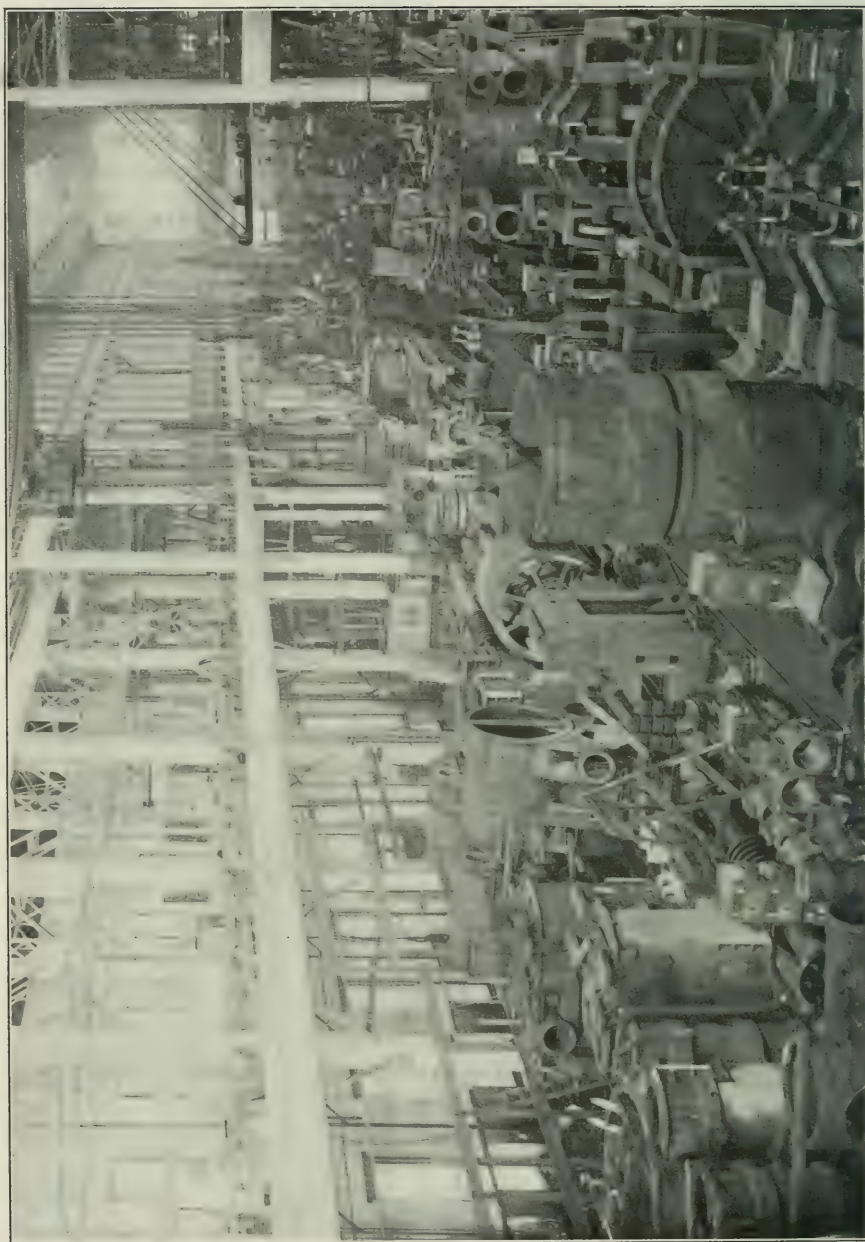


INTERIOR OF MAIN MACHINE SHOP, UNION IRON WORKS.



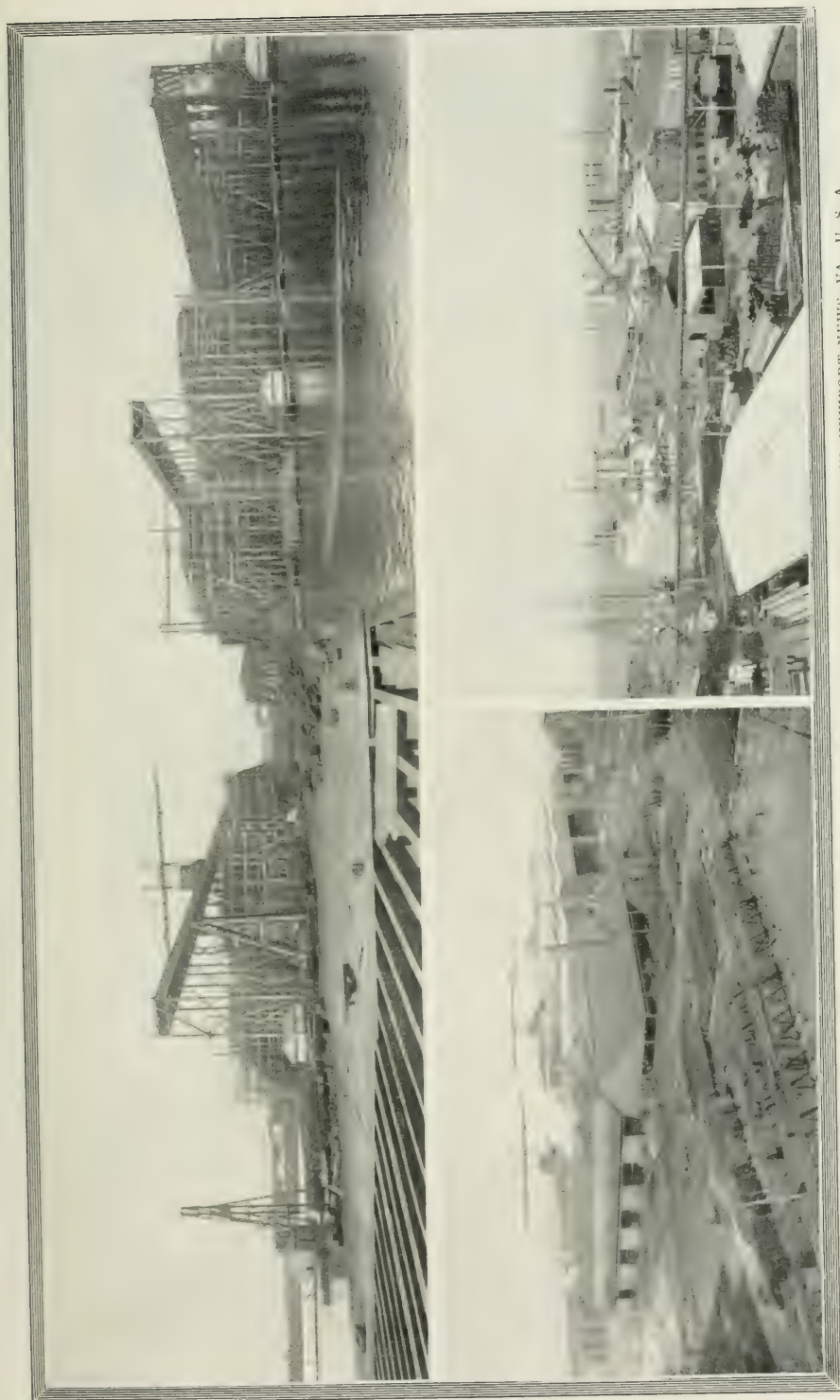
ERECTING SHOPS OF THE UNION IRON WORKS.

In the main shop, shown in the upper picture, the work on the floor includes 12,000-horse-power engines for the United States battle-ship Ohio, twin engines for freighter Alaskan, electric-light engines, and general work; in the small shop, below, the conspicuous feature is the group of six engines for three torpedo-boat destroyers, 4,000 horse-power each.



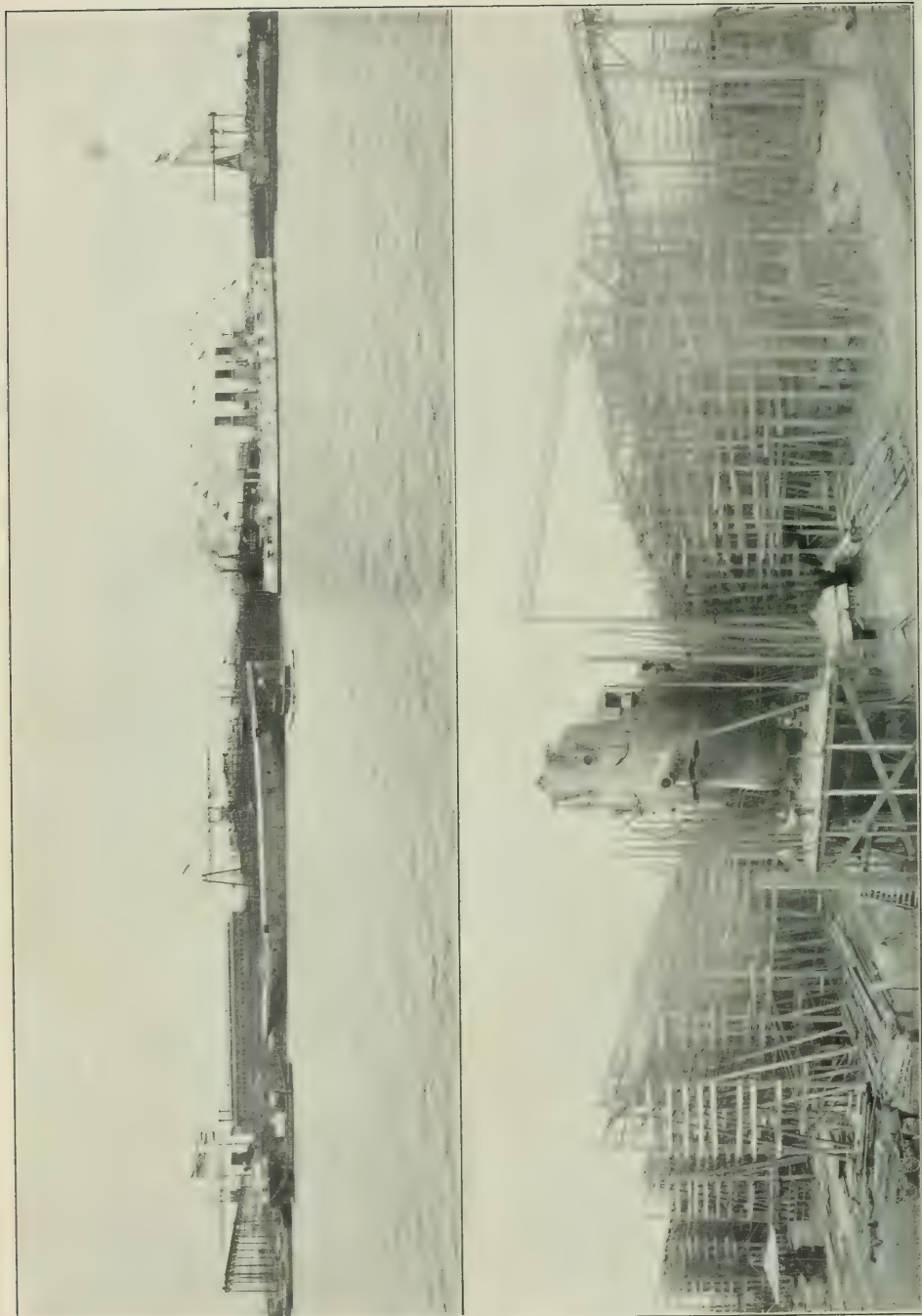
TYPICAL AMERICAN ENGINEERING WORKS, NEWPORT NEWS SHIPBUILDING AND DRY-DOCK COMPANY, NEWPORT NEWS VA.

Interior view of main machine shop, from erection end.



VIEWS IN THE PLANT OF THE NEWPORT NEWS SHIPBUILDING AND DRY-DOCK COMPANY, NEWPORT NEWS, VA., U. S. A.

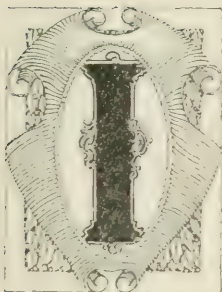
The upper picture shows the north end of the yard, with six ships on the ways; below on the left is a general view from the main office building, looking north, showing the three great cantilever cranes; on the right is a partial view of the lumber department and outfitting slips, showing the 150-ton electric-driven revolving derrick Hercules.



TWO VIEWS OF THE YARDS OF THE WILLIAM CRAMP & SONS' SHIP AND ENGINE-BUILDING COMPANY, PHILADELPHIA, PA., U. S. A. The upper one shows the general water front. At the left is the Morro Castle, the new record breaker between New York and Havana. Next her is the Sierra, which has just made a new record between New York and San Francisco, and next her again the Russian cruiser, Variag. In the slips behind are building the Russian warship Retvizan, the U. S. battleship Maine, and the Ventura and Sonoma, of the Oceanic S. S. Co., sister ships to the Sierra. The lower cut shows the Variag on the stocks, with the Retvizan on the right.

THE RELATION OF THE STEAM ENGINE TO MODERN ECONOMIC PRODUCTION.

By F. R. Hutton.



It is a principle which has been recognized by all writers upon the theory of economics that a proper definition of production must include the expenditure of labor upon raw material, or a product of natural law, whereby its utility to the consuming community shall be enhanced. It is a manifest corollary to this definition of production that the greater number in any community will be able to derive benefit by articles so produced, in proportion as the value of these articles to the producers approaches more nearly to the actual cost of their production. This is, of course, the same thing as to say that the largest market will be found when the largest number of persons are in a position to need and to purchase. Hence, it has become almost an axiom of the present trend of economic production that the most satisfactory returns come from very large outputs of product, in which the profit in each article is small but the aggregate is large.

The very great output of modern establishments and the corresponding economic advantages of such great output are the result of the application of four principles in production, of which America has, perhaps, been the most considerable representative. These are:

1. The Factory System.
2. The Division of Labor.
3. The Special Tool.
4. The Interchangeable System.

Leaving for the present the consideration of the last three items, as covering an area too extensive to be satisfactorily discussed in

The millions of industrial workers of to-day owe their employment, in many instances largely and in others wholly, to the use and the constantly increased economy of machinery. The agency which labour at the outset fought most bitterly, under the delusion that it was its deadly enemy, has proved its Providence—the only conceivable salvation in the crowding struggle for employment. Labour-saving machines have founded, fostered, and filled labour-providing factories.

It should be clear to all that every advance in labour economy will bring the same happy result. The history of the steam engine is the forecast of every movement, either in mechanical invention or methods of management, which tends to lessen or cheapen the labour of production. The certain result of either is vastly enlarged opportunity and augmented reward for the workman.—THE EDITORS.

connection with the first one in the limits of a single article, and turning attention to the first element alone, it will appear that this also is made up of a large number of contributing elements. The factory system has been the step which has succeeded the former method, which may perhaps be called the "Domestic System."

In the domestic system every operator was an individual, working with the tools of his trade in his own house and with the equipment which these conditions imposed. The purchase of the raw materials and the sale of the finished product in the true domestic system formed a series of transactions on a very small scale on the basis of very limited capital. So many objections presented themselves from these points of view that even under the domestic system it was quite usual for the "factor" or master workman to provide for the purchase and sale of raw material and product in the interests of a large number of his work people, for whom he acted as trustee or agent. It will further be apparent that under that system, supervision and inspection, if done at all, were done under great disadvantages and at what would be considered enormous expense under our present conditions. It was scarcely possible that either mechanical appliances on any large scale, or improvements in the tools of the trade, could be procured by workmen under the domestic system, and the application of science and invention would be relatively slow to percolate through the mass of workers, if there were any notable inducement for the making of such applications under that less favorable condition.

It is, however, to the great limiting condition of the domestic system that this article is particularly directed. This limitation is the limited output of the individual, when, besides the knowledge of brain and skill of hand, the laborer must also furnish the endurance of muscle to perform the work of overcoming the resistance in the process of fabrication, whatever it may be. If it was a weaving industry which was in question, the weaver must run the loom as well as tend it; if it were the shaping of metal, the blacksmith must furnish great capacity to endure hard muscular labor; if it were the shaping of wood, the force required to separate its particles must be supplied, as well as the deftness of touch and eye to bring out grace and beauty.

On a step higher than these conditions, where the labor of the human muscle was drawn upon, the historian comes to the places where the labor of animals, such as horses, was made available for hoisting, for pumping, for grinding, and, of course, mainly for transportation. Even here, however, must still be met the noteworthy limitation. The animal tissue and the vital energy wasted in muscular

toil must be recuperated by periods of rest, so that the number of working hours per day of the animal motor has to be kept at a relatively low figure. The expense of the fuel material furnished to the animal motor, in the form of food, is relatively large, and the limitations imposed upon the magnitude of the effort in foot pounds which such a motor can exert for any length of time, keeps all production on a very limited scale as compared with the standards set by the modern requirement. This discussion, furthermore, says nothing whatever upon the humanitarian, or non-material, questions relating to the effect upon the human species of holding him down to a life of unremitting, hopeless, muscular toil, as compared with the uplifting effect of freeing him from the mere animal part of self-support and enabling him to make use of his higher faculties in the process of bread-winning, with the higher pleasures which come to him from this exercise.

It is not too much to say, therefore, that the factory system, with its advantages to the community in the production of its wealth and in the putting of more articles within the reach of the purchasing power of more persons, could not have been made possible without the introduction of sources of motive power to supply that which the factory demanded for the conduct of its processes. The factory brought together a large number of workmen with their appliances for production, and put them under a common supervision with a common source of motive power. The enormously increased production which followed from the combination of all the advantages of the factory system made it possible to arrange for systems of purchase and sale of great advantage to the operatives, on the one hand, and to the community on the other. The aggregation of large numbers of workers made it economically defensible to increase greatly the importance of the machinery of production, and the increased value of the larger volume of output made it significant to induce the application of science and invention to increase the effectiveness of the equipment; so that by introduction of the improved sources of motive power, the modern system is fairly launched.

In tracing the development of the domestic system into the factory system, the historic period is comparatively short. Previous to the introduction of important systems of transportation of goods from one point of production to a market at a distance, nearly all industries were relatively limited to the local consumption in their immediate neighborhoods. The weavers made for themselves and their village; the worker in iron served his community; the farmer raised for himself and the limited number of trades-people who supplied his needs;

the wood-worker made his constructions for those who could call on him from a relatively narrow area. Obviously, therefore, one of the first and greatest developments from the earlier stage to the later would come about with the introduction of the power looms, on the one hand, and the introduction of the processes which made the railroad possible, upon the other. The early third of the eighteenth century and its latter half are the dates to which the student is directed for looking up these tendencies, and mainly in England. Furthermore, until the coming in of the steam-engine, up to which time water power was the only source of considerable units of motor energy, the limitation of production by location favorable to such water-power development would keep the economic growth of a country within narrow limits. We find certain districts in England growing up and becoming important under this favoring condition of their location with respect to water courses, and the same thing in America in those parts of New England where water privileges were to be found and utilized. The wealth-making capacities of the country were awaiting such inventions and improvements as should enable the producing institutions to become widespread.

It is a well-known fact to all students of the early history of the steam-engine, that its first growth was in the mining and other districts where pumping was a considerable problem to be met. The first engines of Savery, Newcomen, and Lord Worcester's inventions were applicable exclusively to pumping, and it was not until James Watt's devotion to the motive problem developed the crank and fly-wheel shaft type, in which the reciprocating motion of the piston could produce continuous rotation of a crank shaft, that the steam-engine became the handmaid of the factory system, in the latter end of the eighteenth century. By replacing the muscle of the human or animal subject by a force tirelessly supplied from the combustion of coal, the problem of aggregation of motive power and its continuous action up to its maximum of effective output became the simple but fundamental condition of modern production. By using the constant and controllable energy of the fuel consumed, instead of the variable and uncertain volume of energy resulting from falling water, a continuity of employment for the laborer and of regularity in the flow of product became the expected, rather than the unusual, condition. It became possible to increase greatly the unit or aggregate of motive power, with all the advantages entailed by bringing such larger units under the supervision of a diminished staff.

It is not an easy process to make a computation which shall appear

to have anything like fairness in a comparison of the relative costs of human or animal motors and the motors which use steam. If it be conceded that, taken for a considerable number of hours, the average output of a human unit is about one-tenth of a horse power, we shall require ten men for each horse power of energy delivered. If the type of human motor employed for this purpose was of an exceedingly low grade in the intellectual or any other scale, it might be obtained for a dollar a day. At \$10 a day, therefore, for the horse power on the above calculation, and for 300 working days in the year, we should expend \$3,000 for the horse power per annum. The calculations which have been made by the best experts concerning the cost of a horse power per annum, as developed in large-size plants through New England, for technical purposes, would seem to indicate that the cost should rarely exceed \$35 per annum if the plant is developing its own steam power on a large scale, and it may fall as low as a little over \$20. The charge for water-power privileges on a large scale, as made by some of the best authorities, would indicate that it is likely to be a little higher than the above figure for the steam-power plant, but that it will rarely be less than \$50 per annum and may rise as high as \$100 for the hydraulically-driven mill. This shows still an enormous margin of economic advantage for the aggregation made possible by the development of the steam-engine, both intrinsically or absolutely and relatively. The relative gain is the result of distributing the charge for motive power over a large number of producing units, each of whom draws only his own requirements of motor energy from the central source, whereas under the domestic system a very much greater aggregate of motor energy is used, by reason of wastefulness of each individual unit by itself.

It is also a well-known principle of the generation of steam power that the proportionate economy increases as the size of the unit increases. There are certain unavoidable losses which are represented by a certain volume of cylinder which has to be filled and exhausted at each stroke, and this relative volume is much smaller with a large cylinder than is that volume with a small one. It has therefore been a sequence of the development of large machine tools, whereby large engine units have become possible, that the development of the large engine has kept pace with the development and increase of the output. This has still further diminished the motive-power charge to be made to each producer-unit, or unit of product, and is a consequence favorable to the theory that the great aggregation of capital resulting in a great establishment is a condition favorable to economic production.

It is a logical consequence and normal growth of the principle of aggregation as represented in the gathering together of workers in the fundamental factory unit. This consideration opens up, furthermore, a most interesting line of thought for future study and observation, when there shall have been more general extension of the principle of generating power in some satisfactory form at a central station of enormous capacity and distributing it to a large number of factory units. It will be apparent that if each factory unit paid the same price for motive-power unit per annum that it is now expending, the aggregation of these large users by the reduction of general and non-productive expense in the development of the power could pay a good profit on the generating enterprise, or the co-operation of the factory units to own the large generating plant themselves could secure for them their motive power at less than the price of the smaller unit. It should be observed, however, with respect to this conception, that when the unit becomes a certain size there is little or no additional economy consequent upon duplicating or multiplying that unit by another factor. That is, when the unit is as large as 1,000 horse power, the economy resulting from increasing the size of the units by simple multiplication becomes inconsiderable or disappears. The 5,000 unit is five times as expensive as the 1,000 unit, so that the cost per unit is the same.

It is interesting in reverting to the domestic principle, to call attention to the fact that in this system the losses incident to transmitting power are little or nothing. The friction of the machine driven by the man's foot is the only loss, and this the factory method does not eliminate. On the other hand, where a large number of machines are driven from a central source of motive power the friction incident to the old method of transmitting power through shafts, gears, belts, and the like, becomes a considerable rebate or discount upon the economies of the concentrated motive-power unit. It is rare that the friction of transmission machinery in any considerable plant is as low as 20 per cent. of the motive power transmitted, and with bad arrangements of the buildings and defective maintenance on the one hand, and with a very large number of light tools on the other, may rise to 40 per cent., and even more. This would point to the enormous advantages incident to the transmission of the power by electrical means, whereby the expense and loss incident to defective transmission can be so materially reduced. If the transmission friction is as low as 20 per cent., the losses in the transmission of the electrical energy about balance out. At greater losses the electrical method comes out ahead.

In the problem of the application of motive power to transportation as a form of production, in the sense that it increases the value or utility of a product, the significance of the development of motive power transcends almost any other consideration. A somewhat impressive example can be derived from the rough calculation of the meaning that would attach to a Transatlantic liner with a 20,000 horse-power engine were that engine to be replaced by 20,000 horse power of human muscles. To run night and day there would have to be three relays of men at the treadmill or other appliance which would be used. Each eight-hour shift at each 10,000 horse-power engine would be 100,000 men, or 200,000 for the two engines. Three shifts of 200,000 men would give below decks a population of a city of second grade. If the problem, moreover, were put in the form of high-speed transportation, such as is represented by the locomotive condition, it disappears practically in the field of the unthinkable. It needs, therefore, but a moment's consideration of the widespread significance which the railroad bears to the modern economic method to bring out the debt which the modern community owes to the motive-power problem, as solved on the railroad. The supply to cities and to their working multitudes of the food in the form of milk, grain, and meat which they require; the distribution of the product of the farm to the market which is to consume it; the disposition of the product of the mill and the factory to the market as extensive as the world—these are the consequences of our modern methods of transportation; all these are recognized as dependent upon the development of the steam-engine. The discussion might further be extended to include the meaning of the pumping engine to the water supply of our large cities (which latter are the direct consequence of the factory principle) and the consolidation of large numbers of workers into one dense area, upon which they expend themselves in the wage-earning processes. The elevator is only a form of the railroad, but the value of property covered by a tall building is a function of the service which the engineer has rendered in making the top floors available.

There are three interesting conclusions which seem to be capable of being drawn from the discussion which has preceded.

The first is that the mechanical engineer, of all the specialists in his great profession, is that type whose influence upon economic production and the prosperity of the community is the greatest. It is he who has developed the economical steam engine, which lies at the root of the factory system, with the economies which this article has aimed to bring out. It is he who has developed the special machinery of

production in the factory, with the economies incident to the greatly increased productivity of the plant and the worker in it. It is he who has applied to the productive processes the knowledge of the laws of force and matter which is called science.

The second conclusion is that it is sound economic theory to attach the skill and ability of the engineer directly to the producing process. This is a tendency of the American method, which manifests itself in the growth of that principle whereby the producer is made responsible for achieving a result which is desired by the consumer or buyer of his product, while the latter does not impose upon him the methods, by specification or otherwise, whereby these results are to be attained. When this method is followed the compensation of the engineer is a charge upon the great output of the producing establishments, and is a charge, furthermore, distributed over a large number of units and is imposed at the moment of the production of their cost. When the consulting engineer is employed as a factor or agent of the buyer or consumer, his compensation is a charge upon the wealth of the community which has been already produced. The community is therefore impoverished to the extent that such engineer is a consumer, and not in the economic sense a producer.

The third conclusion is that there is no logical stopping place for a mind which has admitted the superiority of the factory system, with its effect upon economic production, which seems to be conceded on all sides, until the thinker has carried consolidation upward to the "trust." Or, in other words, the foregoing discussion should constitute a valid argument in favor of the tendency to consolidation and combination which is popularly designated as the trust idea. A grouping together of individual workers is a factory; a grouping of several departments contributing to a common product becomes a plant; a grouping of several plants, each controlled by its own corporate organization, is a trust. The trust, therefore, would appear to reap the advantages of the factory, so far as diminishing the cost of production is concerned, as compared with the cost of production of a number of individual plants working against each other with their own proportion of non-productive expenses. While the trust in its ordinary form and under selfish and short-sighted management is mainly in evidence to the community by its effort to raise the selling price by means of the methods of restricted production or monopoly in production, these are abuses of the principle of consolidation. The economic defence for consolidation which is conceded for the factory should be conceded for the well-managed trust also.



THE TAYLOR DIFFERENTIAL PIECE-RATE SYSTEM.

By Sanford E. Thompson.



O question, perhaps, is exciting more interest at the present day than the labor problem. It is viewed from every conceivable stand-point, and real harmony between employer and employed is looked upon as scarcely more than a Utopian possibility. And yet in nearly every community there are certain establishments, sometimes small and sometimes those employing thousands of hands, in which the best of feeling exists between the employees and the management, in which there is an honest day's pay for an honest day's work, and in which the same men have worked year after year.

The solution of the problem lies, not in compelling either labor or capital by law or coercion to receive or to pay certain fixed wages—not even by merely “creating public sentiment”—but, to a far greater degree, both in industrial establishments and in structural work, through the adoption of methods of management which have been tried and proved.

Nearly fifteen years ago a system of management was introduced by Mr. Fred W. Taylor, of South Bethlehem, Pa., in the works of the Midvale Steel Company of Philadelphia, which has been employed by them with so satisfactory results that it has been introduced into several other large manufacturing concerns. The paper presented by Mr. Taylor before the American Society of Mechanical Engineers, describing this system, has awakened such an interest among those

The piece-rate system is one of the most troublesome questions still unadjusted between employers and employees. It is so manifestly in the line of reason and of progress in the economy of production that the final outcome is in no sort of doubt. Some form of payment by which wage is proportioned to output is sure rapidly to supplant the “day's-work” system. Any method of so presenting or so adjusting a rational plan of piece-working that it may commend itself by its fairness to both sides, is an invaluable service to the manufacturing world. It is in this spirit that Mr. Thompson's article is presented. It has had the revision and approval of Mr. Taylor himself.—THE EDITORS.

interested in manufacturing and also among scientific men, that, with the permission of the author, a revision of the article has been undertaken. With this are presented some results of the system which have come under my observation during my connection with Mr. Taylor in several establishments.

That the ordinary system of piece work will, in general, stimulate a man to do a larger amount of work than he will perform when employed by the day is acknowledged by all who have had experience in the employment of labor; but the methods usually employed involve a permanent antagonism between employers and men, and a punishment instead of a reward for a workman who reaches a high rate of efficiency.

The system introduced by Mr. Taylor consists of four principal elements:

- 1:—An elementary rate-fixing department.
- 2:—The differential-rate system of piece work.
- 3:—A systematic over-inspection of material produced.
- 4:—The management of men who work by the day by methods which reward ability.

In elementary rate-fixing, instead of recording the time for doing whole jobs and fixing the rate on new work by guess, rates are fixed on every elementary operation throughout the establishment and the price of any piece of work is obtained by adding together these detail rates. The simplicity of this method in actual practice will be described later on.

The differential-rate system of piece work consists in offering, for the same job, a high price per piece if the work is done in the shortest possible time and in a perfect condition, and lower prices per piece for slow and imperfect work.

Over-inspection is the means of detecting imperfections in the product.

Mr. Taylor's system of management of men who are on day work consists of paying men, and not positions.

The advantages of this system of management are:

First:—Manufacture is cheapened, and, at the same time, higher wages are received by the workmen.

Second:—A more uniform quality of product is obtained than that resulting from day work or ordinary piece work.

Third:—Rates are fixed by scientific methods and the motives for "soldiering" are removed, while the men are treated with greater uniformity and justice, and it is for the common interest of both manage-

ment and men to turn out a maximum quantity and the best quality of work.

Fourth:—The system is rapid in attaining the maximum productivity, and the maximum is automatically maintained by the differential rate.

Fifth:—The men best fitted for each class of work are automatically selected and the lazy and inferior are sifted out.

Finally:—One of the chief advantages derived from these effects of the system is that it promotes a most friendly feeling between the men and their employers, and so renders labor unions and strikes unnecessary. There has never been a strike under the differential-rate system of piece work, although it has been in operation for the past fifteen years in the steel business, which has been, during this period, more subject to strikes and labor troubles than almost any other industry.

In the manufacturing, or productive branch of the establishment there is opportunity for greater waste and loss than even in the commercial and financiering departments, and the problem confronting one is the necessity for the establishment of a system which is so automatic in its workings as to prevent the dependence upon a single man and to produce harmony between the employer and the employed. The old-school manufacturers believed in men, not methods, in the management of their shops, and their keen insight and knowledge of character enabled them to select and train good superintendents, who, in turn, secured good workmen. The modern manufacturer seeks not only to secure the best superintendence of workmen, but also so to surround each department of his manufacture with a carefully woven network of system and method as to render the business less dependent upon one man, or even upon a combination of men.

Before describing the differential-rate system it is desirable to consider briefly the more important of the other methods.

The simplest of all systems is the day-work plan, in which the laborers receive one rate of pay, all the machinists another rate, all the engineers another, and so on. The men are paid according to the position they fill, without regard to individual character, energy, skill, and reliability. Is it strange that under this system even the most ambitious men soon conclude that there is no profit to them in working hard, but that the best thing for them to do is to work just as little as they can and still keep their positions? It is just this plan that necessitates the formation of the labor union, and produces the antagonism between employer and employed which results in the strike. The neces-

sity for the labor union disappears when the *men* are paid, and not the *positions*.

Every manufacturer must, from necessity, employ a certain amount of day labor which cannot come under the piece-work system; and yet, how few employers are willing to go to the trouble and expense of the slight organization necessary to handle their men in this way! And how few of them realize that by the employment of an extra clerk and foreman, and by the use of a simple system of labor returns to record the performance and re-adjust the wages of their men so as to stimulate personal ambition, the output of a gang of twenty or thirty men can be readily doubled in many cases, and at a comparatively slight increase of wages per capita! A clerk in the factory is the horror of the old-style manufacturer. He realizes the expense each time he looks at him, and fails to see any adequate return. Yet, by the plan here described, the clerk becomes one of the most valuable agents of the company.

Then the question arises: If a system of day work operated by these methods, in which the pay of each man is regulated by the quality and quantity of his work, is so satisfactory, why is there a necessity for piece work? The answer is: Because it is impossible for a foreman to watch all his men all of the time, and the method of recording is more complicated than with piece work.

The step from systematic day work to ordinary piece work is a short one. Where records have been kept, the work has, of course, been divided into sections, and the usual time for doing the work by different men has been recorded; from these records the piece rate may be made. But ordinary piece work has to be in operation but a very short time before its defects are manifest. Each workman with a definite price set for his product contrives to do his work by shorter methods and therefore to make larger the profit to himself. The employer at once decides that he must have a share in these profits, and the rate is cut. After this has happened once or twice, the men perceive that they are getting practically nothing for the extra work and skill which they put in, and they immediately commence to gauge the amount of work which they do. They decide that they can easily turn out a certain amount of product and that, if they turn out no more than this, their employer will maintain the present rate; but if they increase it so that they get too large an amount of money per week, there is a cut. If the leaders among the workmen are shrewd, they can thus maintain a constancy of product greatly below the maximum which would result if each man really did his best. It is a fact that

some of the labor unions, where the members are employed by the piece, fix a maximum day's work, and no man is allowed to exceed it for fear of a cut in rates.

Another way in which the workman obtains high rates in ordinary piece work is by starting very slowly upon a new job. As rates are usually made, day work is necessary at the start, and men may often work at one-third or even one-fourth of their maximum speed and yet appear to be working hard. One method of avoiding this "soldiering" is for the manufacturer to establish rates for a definite time, which tempts the men to let themselves out even at the risk of a reduction in pay at the end of the period.

One or two variations of ordinary piece work have been introduced which require notice. One of these is "gain sharing," which was introduced by Mr. Henry R. Towne in the Yale & Towne Manufacturing Company, Stamford, Conn. Another is the "premium plan of paying for labor," introduced by Mr. F. A. Halsey. Mr. Halsey's plan allows free scope for each man's personal ambition, while Mr. Towne's does not recognize the personal merit of each workman, and the tendency is to herd the men together. In both of these plans there is a temptation for the men to hold back on day work, especially where rates are being fixed. Then again, each new job requires entirely new observations, and rates in different departments are based upon the work of different men at different rates of speed, and, are therefore, variable. The defects of the two systems may be briefly stated thus:

- 1:—The methods of operating are slow and irregular, depending upon the men upon whom observations are taken.
- 2:—They fail to attract superior men and to sift out inferior ones.
- 3:—They do not automatically insure a maximum production.

Co-operation, or profit sharing, has met with partial success. In theory, the general scheme of this system is exceedingly fine, but there are, in practice, several conditions which render it impossible for it to meet with widespread and uniform success. In co-operative establishments the individual has not a scope for his personal ambition. The man who is intelligent or capable of doing a larger amount of work than his fellows, when he sees his fellow workmen in a mill employing one hundred hands receiving 99/100 of the benefit accruing from his extra skill or labor, has very little to stimulate him to continue his extra work. Then, too, the remoteness of the reward prevents men from working at their maximum capacity. Comparatively few men are capable of working for a reward which is a year or more distant, whereas if it comes to them in the form of dollars and cents at

the end of the week, its worth is appreciated. Another, and perhaps the most serious, objection to co-operation is the fact that while the workmen are willing to share the profits, they are unwilling and unable to share the losses.

The real antagonism between men and their employers under ordinary piece work is due on the part of the men to *the universal desire to receive the largest possible wages for their time*, and, on the part of the employers, to *the desire to receive the largest possible return for the wages paid*. Is it any wonder that most of us arrive at the conclusion that no system of piece work can be devised which can enable the two to co-operate without antagonism and to their mutual benefit?

Mr. Taylor lays down the following laws as a basis for harmonious co-operation between employers and employed:

First:—That the workmen in nearly every trade can and will materially increase their present output per day, providing they are assured of a permanent and larger return for their time than they have heretofore received.

Second:—That the employers can well afford to pay higher wages per piece, even permanently, providing each man and each machine in the establishment turns out a proportionately larger amount of work.

The truth of the last statement will be seen when one considers the effect of the volume of the output upon the cost of production. The indirect expenses—which include taxes, insurance, depreciation, rent, interest, salaries, office expenses, miscellaneous labor, and sales expenses, usually amounting in the aggregate to as much as the wages paid to the workmen—remain nearly the same whether the output of the establishment is large or small. It is not unfair to assume that these fixed charges do equal one-half the total expense. Suppose, then, that the men turn out double the amount of work per machine that they have been accustomed to do. Even supposing their rate per piece to be the same as before, there is a saving in the cost of production of 25 per cent., due to the fact that so large a proportion of the expenses remain constant.

In our endeavor to solve the piece-work problem by the application of the two fundamental facts above referred to, let us consider the obstacles in the path of harmonious co-operation, and suggest a method for their removal. The most formidable obstacle is the lack of knowledge, on the part of both the men and the management, of the quickest time in which each piece of work can be done. The remedy for this trouble lies in the establishment of the proper rate-fixing department, organized and conducted in as scientific and practical a

manner as are the engineering and managing departments. Rate-fixing for ordinary piece work is done by a foreman or superintendent who, with the aid of a clerk, looks over the record of the time in which a whole job as nearly as possible like the new one was done, and then guesses at the time required to do the new job. No attempt is made to analyze the time, the classes of work, or the elements of which a job is composed. It is really a far simpler task to resolve each job by Mr. Taylor's methods into its elements, to make a careful study of the quickest time in which each of the elementary operations can be done, and then properly to classify, tabulate, and index this information and use it when required for rate-fixing, than it is to fix rates even with an approximation to justice under the common system of guessing.

A suggestion that this is a practical way of dealing with the piece-work problem usually meets with derision, or, at best, with the answer that "It might do for some simple business, but my work is entirely too complicated." Yet this elementary system of fixing rates has been in successful operation for the past fifteen years on work complicated in its nature, and covering an extreme range of variety in manufacture.

In 1883, while foreman of the machine shop of the Midvale Steel Company of Philadelphia, it occurred to Mr. Taylor that it was simpler to time each of the elements of the various kinds of work done in the place, and then to find the quickest time in which each job could be performed by summing up the total times of its component parts, than it was to search through the records of former jobs and guess at the proper price. It was soon evident that the system was a success, and a rate-fixing department was established which has given out piece-work prices in the place ever since.

A more complicated and difficult system of rate-fixing could not be found than that of determining the proper price of doing all kinds of machine work on miscellaneous steel and iron castings and forgings, which vary in their chemical composition from the softest iron to the hardest tool steel. Yet this problem was solved through the rate-fixing department and the "differential rate," with the final result of bringing complete harmony between the men and the management, in place of the constant war that existed under the old system; at the same time the quality of the work was improved and the output of the machinery and the men was doubled and, in many cases, trebled. At the start there was naturally great opposition to the rate-fixing department, particularly to the man who was taking time observations for the various elements of the work; but when the men found that the

rates were fixed without regard to the records of the quickest time in which they had actually done each job, and that the knowledge of the department was more accurate than their own, the motive for hanging back or "soldiering" on this work ceased, and with it the greatest cause for antagonism and war between the men and the management.

As an illustration of the great variety of work to which elementary rate-fixing has already been successfully applied, it will be of interest to note that Mr. Taylor, while acting as general manager of two large sulphite pulp mills, directed the application of piece work to all the complicated operations of manufacturing throughout one of these mills by means of elementary rate-fixing, with the result within eighteen months of more than doubling the output of the mill.

The difference between elementary rate-fixing and the ordinary plan can be best illustrated by an example. We will suppose that the operation consists of boxing marbles of various sizes and with varying quantities to a box. The entire operation will consist of the following details: getting box, opening box, counting marbles, pouring in marbles, putting on cover, labeling, and setting aside. Instead of timing the complete operation in gross for every size or quantity of marbles, the individual operations are timed. Suppose that, by timing each detail and adding the results, a rate is fixed for one size and one quantity. When a rate is desired for another size and quantity, all the timing necessary may be the counting of the marbles, for the times consumed in work upon the box may be the same as in the other size. Where merely the quantity differs, the time may be obtained by taking a multiple of the time already found for the quantity in the other case, and combining this with the other details. In other words, many of the times of the details remain constant under all conditions. As to the accuracy of this method, all that can be said in so brief an article is that it has been proved to be correct in practice. It has not only the advantage of accuracy, but rates thus obtained are sure to be relatively correct.

The elementary system of rate-fixing is of so great importance that an example taken from Mr. Taylor's paper is given below, illustrating the method of analyzing a machine-shop job. Suppose the work to be planing a surface on a piece of cast iron. In the ordinary system of piece work, the rate-fixer would look through his records of work done by the planing machine until he found a piece of work as nearly as possible similar to the proposed job, and then guess at the time required to do the new piece of work. Under the elementary system, however, some such analysis as the following would be made:

WORK DONE BY MAN.

	Minutes.
Time to lift piece from floor to planer table.....	_____
Time to level and set work true on table.....	_____
Time to put on stops and bolts.....	_____
Time to remove stops and bolts.....	_____
Time to remove piece to floor.....	_____
Time to clean machine.....	_____

WORK DONE BY MACHINE.

	Minutes.
Time to rough off cut $\frac{1}{4}$ in. thick, 4 ft. long, $2\frac{1}{2}$ in. wide.....	_____
Time to rough off cut $\frac{1}{8}$ in. thick, 3 ft. long, 12 in. wide, etc.....	_____
Time to finish cut 4 ft. long, $2\frac{1}{2}$ in. wide.....	_____
Time to finish cut 3 ft. long, 12 in. wide, etc.....	_____

Total: Minutes.

Add — per cent. for unavoidable delays.....

It is evident that this job consists of a combination of elementary operations, the time to do each of which can be readily determined by observation, and while this exact combination of operations may never occur again, elementary operations similar to some of these given will be performed in differing combinations almost every day in the same shop. The rate-fixer soon becomes so familiar with the time for each of the elements that he can write them down from memory. For the part of the work which is done by the machine, he refers to tables which are made out for each machine, giving the time required for any combination of breadth, depth, and length of cut.

It is one thing to know how much can be done by the workmen and an entirely different matter to get even the best men to work at their fastest speed. The method found to be the most effective in obtaining a maximum output of a shop was by means of the differential rate.

The differential-rate system of piece work consists briefly in paying a higher price per piece (or per unit, or per job), if the work is done in the shortest possible time and without imperfections, than is paid if the work takes a longer time or is imperfectly done. Perhaps the simplest way of describing the differential rate is to give an illustration. We will suppose that in a certain kind of work a man finishes when working nearly at his maximum speed, twenty pieces per day. The rate, then, for twenty pieces per day may be fixed at 15 cents per piece, making his day's pay \$3.00. If, instead of turning out twenty pieces, he turns out only nineteen, his rate, instead of being 15 cents, may be 12 cents per piece, or \$2.28 per day, scarcely more than he received when working by the hour. If, on the other hand, he turns

out twenty pieces and some of them are of inferior quality, there may be a deduction of, say, 5 cents per piece, so that he receives for the entire twenty at the rate of 10 cents per piece, or \$2.00 per day.

Now, what would have occurred under the ordinary piece-work plan? Let us suppose that, under the ordinary system of piece work, the workman has been turning out sixteen pieces per day at the rate of 15 cents per piece, making his day's wages $16 \times 15 = \$2.40$. Through extra exertion he succeeds in increasing his output to twenty pieces per day, and so increases his pay to \$3.00. Now we come to one of the fundamental differences between Mr. Taylor's methods and the common practice in piece work. The employer under the old system sees that this workman is earning \$3.00 per day, while other men are only getting from \$2.25 to \$2.50, and accordingly he immediately cuts the price from 15 cents per piece to 12 cents, and the man finds himself working very much harder and yet earning only the same old wages, $20 \times 12 = \$2.40$ per day. Is it strange that men do not care to repeat this performance many times? Can anyone blame them for making a rule among themselves that a certain output shall not be exceeded?

In any system of management a principle which must always be recognized is that *a man will not do an extraordinary day's work for an ordinary day's pay*, and any attempt on the part of the employers to get the best work out of their men, and at the same time pay them no more than the standard wages paid by their neighbors, will surely be, and ought to be, doomed to failure. Justice, however, not only demands for the workman an increased reward for a large day's work, but should compel him to suffer an appropriate loss in case his work falls off either in quantity or quality.

The differential rate satisfies automatically the conditions of properly graded rewards and deductions. Whenever a workman works for a day, or even a shorter period, at his maximum, he receives unusually high wages provided he does perfect work. If his work is not up to the standard in quality, however, he may receive less pay than a good workman who does a considerably smaller amount of work. The great advantage of the differential-rate system is that it quickly drives away all inferior workmen and attracts the men best suited to the class of work to which it is applied. None but really good men can work fast enough and correctly enough to earn the high rate, and the low rate should be made so small as to be unattractive, even to an inferior man.

If for no other reason than that it secures to an establishment a

quick and active set of workmen, the differential rate is a valuable aid, since men are largely creatures of habit. If the piece workers of a place are induced to move quickly and work hard, the day workers soon get into the same way and the whole shop takes on a more rapid pace. The differential rate acts automatically, and punishes the poor workman for imperfect work as well as rewards the good man for perfect work.

One of the most important branches of a proper piece-rate system is the over-inspection. Unless one has been personally acquainted with the effects of a careful system of piece-work management, the conclusion is formed that, if an extra quality of product is desired, even in an establishment customarily employing piece rates, day work must be resorted to. In actual fact, the contrary is absolutely true. This is, perhaps, best illustrated by an example of piece-rate methods which have been introduced by the writer under the direction of Mr. Taylor in a manufacturing establishment. The work in the department under consideration consisted of the examination of material produced in other departments. Until Mr. Taylor undertook the introduction of his piece-rate methods, this work was done by the day. After the piece-rate system had been in operation in the department for three months, the employees were doing just twice the amount of work per day that they did before the system went into effect. They were doing this quantity of work in eight and one-half hours instead of ten and one-half under the old management, and they were turning out a quality of product which by actual unbiased test showed an improvement of about 25 per cent. over previous work. The improvement in quality was obtained by thorough over-inspection. Over-inspection, where possible, should isolate the work of each man, so that each will receive pay for his own work and the total will depend entirely upon himself. Where, however, the work is done in small gangs, the result is nearly as satisfactory as where each man's work is separated, because the good men force the drones either to work hard or to quit.

A proper rate-fixing department is an essential to any piece-rate system, and is, in fact, by far the most important branch of the work. It is not within the scope of this article to describe the proper methods of making up rates, but a scientific course should be followed and no rates made by guess. A careful study is necessary of the capabilities of the machines and the speeds at which they must run. Records of the times of doing work under all conditions must be most carefully made and tabulated.

The most important results of piece-rate methods, such as introduced by the system described, are the promotion of a proper mental attitude between the men and the management. It is for the interest of both to co-operate and turn out a maximum quantity and the finest quality of work. The indirect results attained are by no means small. It is absolutely necessary for the machines to be kept in good repair. If a machine breaks, the workman will either repair it himself to avoid loss of time in hunting up some one else to do it, or will report it before it commences to affect the material. Defects in the design of the machinery are brought to notice, and improvements suggested both by the management and the men. It is necessary, also, to systematize the other details of manufacture in such a way that there will be smooth running and no friction in any of the departments.

The object of the differential-rate system is not to force a man to over-exert himself, but to permit of a "natural selection" whereby men gradually sift themselves into jobs for which they are fitted by nature and training. For example, in shovelling coal from a car over the side onto a pile, the man who may be, perhaps, so mentally inert as to prevent him from any attainments which require skill, will unload 40 tons per day and keep it up year in and year out and thrive under it. This is not a supposition, but a statement of what is actually being done. Accordingly, men may be found anywhere who are glad to work at a piece rate of from $4\frac{1}{2}$ to 5 cents per ton and will make good wages. Yet the average speed for unloading coal, in most places, is nearer 15 tons than 40 tons per day.

A standard steel forging, many thousands of which are used each year, had for several years been turned at the rate of from four to five per day under the ordinary system of piece work, 50 cents per piece being the price paid for the work. After analyzing the job and determining the shortest time required to do each of the elementary operations of which it was composed, and then summing up the total, Mr. Taylor became convinced that it was possible to turn ten pieces a day. To finish the forgings at this rate, however, the machinists were obliged to work at their maximum pace from morning to night, and the lathes were run as fast as the tools would allow, and under a heavy feed.

It will be appreciated that this was a big day's work, for men and machines, when it is understood that it involved removing with a single 16-inch lathe, having two saddles, an average of more than 800 pounds of steel chips in 10 hours. In place of the 50-cent rate that they had been paid before, they were given 35 cents per piece when they

turned them at the speed of ten per day, and when they produced less than ten, they received only 25 cents per piece.

It took considerable trouble to induce the men to turn at this high speed, since they did not at first fully appreciate that it was the intention of the firm to allow them to earn permanently at the rate of \$3.50 per day. But from the day they first turned ten pieces to the present time, a period of more than thirteen years, the men who understood their work have scarcely failed a single day to turn at this rate. Throughout that time, until the fall in the scale of wages throughout the entire country, which occurred a few years ago, the rate was not cut. During this whole period the competitors of the company never succeeded in averaging over half of this production per lathe, although they knew and even saw what was being done. They, however, did not allow their men to earn over \$2 to \$2.50 per day, and so never even approached the maximum output.

The following table will show the economy of paying high wages under the differential rate in doing the above job :

COST OF PRODUCTION PER LATHE PER DAY.

ORDINARY SYSTEM OF PIECE WORK.		DIFFERENTIAL-RATE SYSTEM.	
Man's wages	\$2.50	Man's wages.....	\$3.50
Machine cost.....	3.37	Machine cost.....	3.37
Total cost per day.....	\$5.87	Total cost per day.....	\$6.87
5 PIECES PRODUCED.		10 PIECES PRODUCED.	
Cost per piece.....	\$1.17	Cost per piece.....	\$0.69

The above result was mostly, though not entirely, due to the differential rate. The superior system of managing all of the small details of the shop counted for considerable.

There has never been a strike by men working under differential rates, although these rates have been applied at the Midvale Steel Works for the past fifteen years, and the steel business has proved during this period the most fruitful field for labor organizations and strikes. And this, notwithstanding the Midvale Company has never prevented its men from joining any labor organization. All of the best men in the company saw clearly that the success of a labor organization meant the lowering of their wages, in order that the inferior men might earn more, and, of course, could not be persuaded to join.

The moral effect of the Taylor piece-rate system on the men is marked. The feeling that substantial justice is being done them renders them, on the whole, much more manly, straightforward, and truthful. A noted French engineer and steel manufacturer, who re-

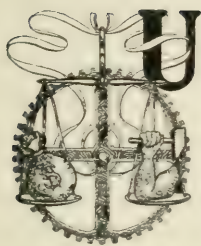
cently spent several weeks in the works of the Midvale Steel Co. in introducing a new branch of manufacture, stated before leaving that the one thing which had impressed him as most unusual and remarkable about the place was the fact that not only the foreman but the workmen were expected to, and did in the main, tell the truth in the case of any blunder or carelessness, even when they had to suffer for it themselves.

In order to maintain harmony between the men and the management, a thorough reorganization of the machinery and tools and the methods of keeping records, as well as of the wages of the men, is often necessary; for that reason it is probable that the general introduction of this or a similar scientific system will be gradual. The chief necessity in practice is not so much the differential rate (although this is very advantageous, especially at the time of introduction), as it is a principle of fixing rates by which the men will know that they are being honestly and fairly dealt with. The whole benefits of the system are destroyed if the men receive the impression that as soon as their output is increased their wages will be reduced.

Piece work has been relegated to constantly repeated operations under exactly similar conditions. Mr. Taylor has shown it capable of wider application; he has shown that it can be employed in the most complicated work and varying conditions. There is a still wider field which is open to this system. In the building trades, lathing is done by the piece, and in engineering construction, sewer-brick laying, and it is a matter of record that an average mason working by the thousand will lay nearly twice as many brick as a man on the roughest kind of a wall above ground when at work by the day. The question arises: If piece-work methods can be satisfactorily employed in molding, chipping, and machining a special casting which is only one pattern of a thousand produced from a foundry, why cannot the principle be applied to various branches of engineering and structural work which are really very much less intricate than the examples of machine-shop practice cited? Sooner or later, our day laborers will be working by the piece, and the hard worker will not receive the same rate of pay per day that is given to the man beside him who shirks whenever possible. Piece work may be started as a result of competition for contracts, on account of the larger amount of work which a man will do when working by the piece; but, if once established, it will be as jealously preserved by the laboring man as by his employer.

THE PREMIUM PLAN OF LABOR REMUNERATION.

By H. M. Norris.



UNDER the terms of the joint agreement entered into between the National Metal Trades Association and the International Association of Machinists, May 18th, 1901, will witness the adoption of a nine-hour working day throughout American machine shops. The question of wages and cost reduction is ever an interesting theme to both manufacturer and workman, but with the approach of this 54-hour-week the problem assumes a phase of almost alarming importance, being no longer a matter of augmenting profits, but of maintaining profits—of gaining for manufacturers and employees in nine hours the same remuneration made formerly in ten.

Mr. O'Connell, the official representative of the International Association of Machinists, makes in his reply to my two former papers on the premium plan this statement: "I have come to the conclusion that a goad is unnecessary to drive the average American workman," but "the time has come when a stimulant would not be an injury." Piece-work he speaks of as an "insidious disease." Its enforcement, he says, "will breed disorder in any shop." The International Association of Machinists is opposed to it, "and will never be a willing party to its propagation."

The *stimulant*, therefore, must come from some other source, since it is through the co-operation of the employees only that satisfactory results are possible.

Imbued, as Mr. O'Connell says he was, with the feeling that if the premium plan "was honestly tried and its promises honestly lived up to, it might prove of great value in reducing the friction that always asserted itself when anything in the nature of piece work was hinted at," it is greatly to be regretted that he was not able to visit the local

The exposition of the premium plan is fittingly placed beside that of the intensified piece-rate system. It is the other great alternative argument, reduced to practical form, offered to the workman in the effort to smooth and make easy the inevitable movement toward paying for production according to the quantity and quality of the product. Mr. Norris, like Mr. Thompson, writes from the standpoint of a practical employer of the system he advocates. Both are leaders who have tested their tactics under fire. Both wear the authority conferred by success.—THE EDITORS.

branches of his association prior to their convention held in Buffalo, New York, in May, 1899, in order that he might lay before them the same evidence of its merits as had caused him to indorse it. For it is under *this system* that "both workman and employer can achieve all their desires without having recourse to any measure that is repulsive to human nature, or disastrous to their mutual interest," and nothing short of ignorance of its principles could have caused its rejection. To understand it is to accept it—not as the best of the bad, but as the best of the best, and once accepted, no man will willingly give it up.

Inasmuch as not all the readers of THE ENGINEERING MAGAZINE may have a perfectly clear understanding of just what the premium plan claims to do for the employer and workman, a brief description of the system may not come amiss. This I will give in the inventor's own words, culling from his "Experience with the Premium Plan of Paying for Labor":

"The premium plan is an application to production of methods long in use in connection with sales. The plan of offering a salesman a salary and a commission is closely analogous to the premium plan, and if for the salary he is expected to sell a certain minimum of goods per annum, the commission applying only to the excess above this minimum, the analogy is exact. Under the premium plan, the workman is paid by the day, and for this daily pay is expected to produce a certain minimum of product, while for an excess beyond that amount he is paid a premium, the amount of this premium being based on the excess and being less per unit of product than the old wages cost.

"Suppose a workman to be paid three dollars per day of ten hours and to produce one piece of a certain kind per day. The wages cost of the product per piece is obviously three dollars. Now, under the premium plan, the proprietor says to the workman: 'If you will reduce the time on that piece, I will pay you a premium of ten cents for each hour by which you reduce the time.' If a reduction of one hour is made, the first result to the employer is to save the wages of thirty cents for the hour which has been saved, but against this is to be placed the ten cents earned as a premium, leaving a net gain of twenty cents to the employer and a net increase of earnings of ten cents to the employee. Had the premium offered been fifteen cents, the result of an hour's reduction of time would have been to save fifteen cents to the employer and to increase the workman's earnings by the same amount. The result of any saving is, therefore, divided between the two, and in a proportion determined by the proportion established between the wages rate and the premium rate. It is obvi-

ous to all, however, that the gain to the employer does not stop here—the gain due to the increased output from a given-sized plant being additional to the immediate cash gain. In the case of large, expensive tools, the gain due to increased output may easily far exceed the gain due to the reduction of wages paid per piece.

"The plan in a sense splits the difference between the day's-work and the piece-work plans. Under the day's-work plan any increase in production by a workman results in an immediate gain to the employer only, the workman getting nothing for his efforts until some time in the indefinite future, when merit, coaxing, cajolery, pulls, or all four together, result in a trifling 'raise' in his wages. Under piece work, on the other hand, an increase in production, after the piece price is once set, results in an immediate gain to the employee only—the employer paying the same wages per unit of production as before, until some time in the future when the workman's earnings have risen to a point where they seem to demand a cut in the piece price.

Passing now from the abstract to the concrete, I show on the next page the front and back of one of our comparative time cards, upon which is given the time consumed on each shop order in performing the several operations on one of our staple articles of manufacture. The columns headed 1, 2, and 3 refer respectively to the lines marked 1, 2, and 3 on the front of the card, and show that the total time consumed in the three operations has been cut from $28 + 86\frac{3}{4} + 33\frac{3}{4}$ to $18 + 48 + 18 = 64\frac{1}{2}$ hours. The time limits on this work were fixed at the completion of the order marked with an asterisk, 27 hours being allowed for boring, 66 for planing, and 27 for drilling and tapping.

If, now, this reduction had been effected under the day's-work plan, it is obvious that the immediate cash gain to us would be—taking the time limits as a basis and figuring wages at 24 cents per hour for boring, 26 cents for planing, and 22 cents for drilling and tapping— $\$24 (27 - 18) + \$26 (66 - 48) + \$22 (27 - 18) = \$8.82$. If, on the other hand, the reduction had been effected under the piece-work system—the piece prices being taken at $27 \times \$24 = \$6.48$, $66 \times \$26 = \$17.16$, and $27 \times \$22 = \$5.94$, respectively—it is equally evident that this additional profit would have gone solely to the workmen. Under the premium plan, however, the immediate cash gain of \$8.82 was equally divided between the workmen and ourselves— $\$.12 (27 - 18) + \$.13 (66 - 48) + \$.11 (27 - 18) = \$4.41$ going to the workmen and an equal amount to us.

The saving in time on this job is as 84 is to 120, or as 70 is to 100, and in order to show that cuts of this amount are in no way unusual,

I give, in Table I, the results obtained by one of our employees in 1,770 hours' continuous work under the premium plan, in which it will be noted that the new time is to the old time as 1,770 is to 2,500, or as 70.8 is to 100.

COMPARATIVE TIME CARD.			
UNIVERSAL HEAD.			
SYMBOL 2M14.		TIME ON 6 PCS.	
OPERATIONS		TIME	S. U.
1	Boring	27	
2	Planing	66	
3	Drilling and Tapping	27	
4			
REMARKS: Time limit was fixed on completion of Order No. 379.			

ORDER	JOB	1	2	3	4
132		28	86 $\frac{3}{4}$	33 $\frac{3}{4}$	
267		27 $\frac{1}{4}$	81	29 $\frac{1}{4}$	
315		27	69	27	
379*		26 $\frac{3}{4}$	63	24 $\frac{1}{2}$	
423		22 $\frac{1}{2}$	53	20	
576		20	51	19 $\frac{1}{4}$	
632		19	49 $\frac{1}{2}$	18 $\frac{1}{2}$	
1127		18	48	18	

FRONT AND BACK OF COMPARATIVE TIME CARD UNDER THE PREMIUM PLAN OF WORKING.

The data furnished by this table are particularly valuable in that they show, in many cases, the time consumed in performing the identical operation on successive lots of the same piece—ditto marks being used to indicate repetition work. Records 4 to 10, for instance, were all made on the same work, and show how, after the second cut was made, it was some time before the minimum of 18 hours was reached. Attention is also called to item 2, in which it will be noted that the time was cut from 72 to 50 $\frac{1}{2}$ hours at one leap. Items 19 to 24 are also interesting, as showing the gradual shrinkage from the first drop of 14 hours to the last record of 35 hours.

Taken all together, this table is an excellent example of what may be expected of the premium plan, the records throughout having been

ITEM	NO. PCS IN LOT.	TIME LIMIT.	ACTUAL TIME.	PREMIUM EARNED.	FORMER WAGE COST.	PRESENT WAGE COST.
1	2	20	14.	\$.78	\$ 5.20	\$ 4.42
2	18	72	50.50	2.80	18.72	15.92
3	18	180	126.75	6.92	46.80	39.88
4	6	30	23.25	.88	7.80	6.92
5	"	"	20.75	1.20	"	6.60
6	"	"	20.50	1.24	"	6.54
7	"	"	20.50	1.24	"	6.54
8	"	"	20.25	1.26	"	6.52
9	"	"	18.	1.56	"	6.24
10	"	"	18.	1.56	"	6.24
11	16	80	58.50	2.80	20.80	18.00
12	"	"	57.25	2.96	"	17.84
13	"	"	52.	3.64	"	17.16
14	6	66	54.	1.56	17.16	15.60
15	"	"	49.	2.21	"	14.95
16	"	"	48.	2.34	"	14.82
17	"	"	48.	2.34	"	14.82
18	6	66	49.	2.21	17.16	14.95
19	6	54	40.	1.82	14.04	12.22
20	"	"	38.	2.08	"	11.96
21	"	"	37.50	2.15	"	11.89
22	"	"	36.	2.34	"	11.70
23	"	"	35.75	2.37	"	11.67
24	"	"	35.	2.47	"	11.57
25	12	144	103.75	5.23	37.44	32.21
26	"	"	103.50	5.26	"	32.18
27	"	"	97.	6.11	"	31.33
28	12	150	102.75	6.14	39.00	32.86
29	"	"	102.	6.25	"	32.75
30	2	26	21.50	.59	6.76	6.17
31	10	105	73.	4.16	27.30	23.14
32	6	21	16.75	.55	5.46	4.91
33	"	"	16.50	.59	"	4.87
34	6	30	23.	.91	7.80	6.89
35	12	66	48.	2.34	17.16	14.82
36	2	30	22.	1.04	7.80	6.76
37	12	39	29.25	1.24	10.14	8.90
38	6	54	40.50	1.76	12.96	11.20
TOTAL.....		2500hrs.	1770 hrs.	\$94.93	\$650.00	\$555.06

TABLE I.—SHOWING THE GAINS IN WAGES EFFECTED IN ACTUAL PRACTICE BY ONE OF THE EMPLOYEES OF THE BICKFORD DRILL & TOOL CO. IN 1,770 HOURS' CONTINUOUS WORK UNDER THE PREMIUM PLAN, TOGETHER WITH THE FORMER AND PRESENT WAGE COST OF THE WORK.

made by the same man on the same tool by the same method under the same conditions.

The greatest amount earned by the workman in excess of his wages during this period of 1,770 hours was made on jobs 9 and 10, the premiums being \$1.56 each for 18 hours' work, or 8.66 cents per hour; while the smallest amount earned in excess of his wages during this time was made on job 30, the premium being 59 cents for $21\frac{1}{2}$ hours' work, or 2.74 cents per hour. The average of the whole, however, is $94.93 \div 1770 = .0536$, or a little over $5\frac{1}{3}$ cents per hour, making a very substantial increase in wages.

Just what effect this reduction in time had upon our profits is not so easily answered. We know, only, that we saved \$650.00 — \$555.06 = \$94.94 in wages on this particular man's work. If, now, we figure general expense at 20 cents per hour, our profits were apparently augmented by the additional saving of \$.20 (2500 — 1770) = \$146.00. And we must not stop here, for there is the gain due to a more rapid turn-over of our capital, which must also be considered.

Suppose that the 2,500 hours represents the time it consumed originally to build a complete machine, the material for which cost \$500. Suppose, further, that the selling price for this tool is \$1,980 and that wages and general expense are 26 cents and 20 cents respectively. Our profits then were: $\$1980 - [2500 (\$.26 + \$.20) + \$500] = \$330$, or $330 \div 2500 = 13.2$ cents per hour. Made in 1,770 hours under the premium plan, however, our apparent profits are: $\$1980 - [1770 (\$.26 + \$.20) + \$.13 (2500 - 1770) + \$500] = \$570.90$, or $\$570.90 \div 1770 = 32.25$ cents per hour, or $32.25 - 13.2 = 19.05$ cents per hour greater than when the work was done under the day's-work plan.

Figured on this basis, a reduction in time by one-half results in an increase in profits of from 30 to 35 cents per hour, according to the rate of wages paid the workmen. For example, if the cost and selling price of a piece of work requiring originally 60 hours to construct were equal, a reduction in time by one-half effected by a 20-cents-per-hour workman would result in a gain to the manufacturer, under the premium plan, of 30 cents per hour. Likewise, a cut of 30 hours by a 30-cents-per-hour workman would mean an increase in profits of 35 cents per hour, the gains per hour increasing with every change of rate in wages, as shown by Table II., on the next page.

We all know, however, that with every increase in production comes a corresponding increase in expense, each augmentation in output requiring more motive power, more inspectors, and more laborers,

TIME CONSUMED.	RATES OF WAGES					
	.20	.22	.24	.26	.28	.30
60	.0000	.0000	.0000	.0000	.0000	.0000
54	.3333	.0344	.0355	.0366	.0377	.0388
48	.0750	.0775	.0800	.0825	.0850	.0875
42	.1286	.1328	.1371	.1414	.1457	.1500
36	.2000	.2067	.2133	.2200	.2267	.2333
30	.3000	.3100	.3200	.3300	.3400	.3500

TABLE II.—SHOWING HOW PROFITS INCREASE UNDER THE PREMIUM PLAN AT DIFFERENT RATES OF WAGES, AS THE TIME CONSUMED ON WORK IS REDUCED FROM 60 TO 30 HOURS.

to say nothing of the losses due to the additional wear and tear on plant, the greater consumption of supplies, and the occasional re-working in one department of work that has been more or less slighted in some other, which items, although comparatively small in themselves, mount up in the aggregate to a considerable sum.

Two fundamental questions which must be settled before the system is put into operation are, on what basis shall the time limit be set, and what percentage of the saving shall be given to the workman? On these points Mr. Halsey says: "One method—and the wrong one—is to take the best record obtainable as a base, and then offer a liberal premium for its reduction. * * * I have adopted the settled policy of being liberal with the time rate, rather than the premium rate. * * * I am now satisfied that the principal danger to the success of the plan lies in the tendency to adopt the opposite course. At first the proprietor is disposed to be liberal, and expecting a small increase only, he offers large premiums. The premiums should at the start be too small rather than too large. If found too small, they can be raised, but if too large, they cannot be cut without destroying the confidence of the workmen in the system and in their employers' intentions. It must be remembered that in a large proportion of machine-shop work, increased production calls for little or no increase of labor on the part of the workman. It is in such cases more a matter of using his wits than his muscles. In other words, he crowds the machine rather than himself. * * All experience, however, shows that the increase of output will be far more than anyone expects, and the premium rate should be decided with that point in mind. A practical way of looking at the matter is to assume the output to be doubled, as the extreme possible, and then to decide how much the shop can afford to raise pay to secure such an increase. * * * It will be seen that a large element of judgment must enter the

administration of the system. I am in fact fully convinced that the system puts a sharper test on the capacity of the management than it does on that of the workmen, and this fact will determine the limits of its application."

For the average shop, changing from the usual lax method of the day's-work plan to the premium plan, I believe Mr. Halsey's policy of liberality with the time rate rather than the premium rate is the correct one; but where a shop has already been placed on an efficient basis, I feel that there are frequently conditions which warrant the management in adopting the opposite course. In the works of The Bickford Drill & Tool Company I have made it the practice to fix the time limit at what seemed a fair day's work for the average machinist, and to divide wages equally on all time saved on this limit. I consider that the chief gain to us comes from the increased output, rather than from the reduced wages per piece, and that if the time limits are fixed with proper precaution, the general results are more beneficial than where the limits are high and the rates low. I have, it seems to me, two good reasons for adopting this course. The first is that it fixes a higher standard of efficiency for the workmen—each being required to produce a minimum of so much work per hour in return for his regular wages. Time is the all-important factor, and unless kept down, profits soon vanish. Suppose, for instance, that 10 hours represents a fair allowance for a certain piece of work, the selling price of which is \$6, our profits are obviously $6 - 10 (\$.30 + \$.20) = \$1$, or 10 cents per hour. If, now, we permit some other workman to spend 12 hours on the job, the result is a direct loss of $2 (\$.10 + \$.30 + \$.20) = \$1.20$, showing that it is the rapid men only that we can afford to keep. I believe, therefore, that for the average shop, operating on a narrow margin of profit, that plan is the best which most quickly weeds out the slow workmen. And this is equally true of the day's-work plan. Wherever competition is sharp between manufacturers, prices fall with increased production, and there must be no slipping back. To avoid this it has long been my custom to place limits on all our work, not only as an aid to the cost clerk in detecting any falling behind in our output, but in order that wages might be graded according to the individual ability of the workmen. Where one man receives 30 cents per hour for performing certain work in 17 hours, I felt that another workman taking 20 hours for the same operation received as much as he was entitled to if we paid him $[17 (\$.30 + \$.20) - (20 \times \$.20)] \div 20 = 22\frac{1}{2}$ cents per hour—this being the maximum rate we could give him without cutting into our profits.

My second reason for using lower time limits and higher premium rates than recommended by Mr. Halsey is that I believe that after a workman has made his first cut he has less incentive to effect further reductions if each saving brings him, for instance, an increase of only a quarter of his wages instead of a half. The first cut is usually accomplished with very little additional exertion on the part of the workman, but after that increased production is apt to call for increased muscular labor, as well as an increased tax upon the mind, and should, I feel, be rewarded with the higher rate of premium.

I do not wish to be understood, however, as recommending the adoption of this higher rate for the average shop, for I am sure that it would sooner or later cause the downfall of the system. Human nature is the same the world over, and while a manufacturer may console himself for a time with the thought that every additional cent earned by the workman means one, two, or three cents saved to him, there will come a time when he will feel that he was imposed upon at

ORDER NUMBER.	NO. PIECES IN LOT.	TIME CONSUMED.	WAGES PER DAY.	COST PER PIECE.
374	6	78	\$2.00	\$5.20
489	6	62	2.00	4.13
524	6	56¼	2.00	3.75
769	6	54½	2.00	3.63
943	6	42¾	2.00	2.85
1128	6	40¾	2.00	2.72
1331	6	38¾	2.00	2.58
1569	6	18½	3.16	1.59
1698	6	19	3.10	1.62
1747	6	18	3.22	1.57

TABLE III.—SHOWING THE GREATEST REDUCTION IN TIME THAT HAS BEEN EFFECTED UNDER THE PREMIUM PLAN AT THE WORKS OF THE BICKFORD DRILL & TOOL CO.

the start—that the men were previously laggards—and that now they are getting much more than they deserve; then follows a cut, and with it comes the disruption of the system.

In order to present as clearly as possible the danger of adopting too high a premium rate, I give, in Table III, the actual records made in machining ten successive lots of a certain piece of work. It so happened that this job was not offered under the premium plan until the completion of order No. 1331, when the limit was fixed at 40 hours. From a best previous record of 38¾ hours, the time is reduced to 18½ hours in the first cut, and from that finally to 18 hours. Suppose, now, that we had had occasion to fix the limit at the commencement of order No. 769. It is possible that we would have allowed 60

hours for the work, in which case the workman's last earnings—under a quarter-wage rate, his wages being 20 cents per hour—would have been \$3.16 per day, while his last earnings under a half-wage rate would have reached \$4.33 per day—showing how rapidly wages advance under the higher rate of premium.*

Just one thing more. In no case yet where the plan has been introduced have the employees received it with any feeling other than of suspicion. They appear to regard it as the entering wedge to piece work. Any management installing it must, therefore, expect to meet with considerable opposition at the start, but "even from this point of view," says Mr. Halsey, "the system has decided advantages in that it does not involve compulsion. * * * In the shops where the plan has passed the trial stage, it is uniformly popular with the men—indeed, a plan which deliberately sets out to increase wages can hardly be otherwise than popular when it is once understood, and it is the uniform experience that after the workings of the plan have been shown there is a steady call from the shop for more work to be given out on premiums."

It is obvious that increased earnings can be made only through the reduction of costs. This the premium plan secures, bringing it within the pale of the strictest principles of economics. Were it otherwise, it could never have stood the test of the sixteen years that have elapsed since the date of its inception. What the workman desires is high wages per day, and what the manufacturer must have is low cost per piece, both of which needs the premium plan meets—equitably, harmoniously, automatically—and in a way that introduces a spirit of co-operation which goes further toward settling the wage problem than anything else that has been suggested. There is no goading or whip-cracking, no threats, fines, or punishments, no herding together at so much per head. Instead of being held down to "the average wage paid in his locality," the workman preserves his individuality. He is given an opportunity to profit by his industry. He is raised from a mere automaton to a man, alive to the possibilities of bettering his condition—an intelligent worker, certain of receiving a just share of his employer's profit. Is it not clear—can it not be made clear?—that here is the path to the goal that both parties have striven so long to reach—high wages and low cost.

* This work, prior to being given out under the premium plan, was done in two operations. The workman first machined all the pieces in the lot, and then babbitted them. Encouraged by the certainty of reward for his extra exertion, he afterward combined the two, doing his babbitting on one piece while his machine was engaged on the next, thereby effecting the tremendous saving shown.

A SURVEY OF MODERN FOUNDRY PRACTICE.

By Percy Longmuir



FOUNDRY, be it iron, steel, or brass, of any large establishment, is almost always looked upon and treated as the necessary evil of the concern. Pounds upon pounds are spent on up-to-date machinery and modern labour-saving devices of all kinds, for the pattern-making, machine-tool, and kindred departments. The heating, ventilating, and lighting arrangements of these departments are generally of a fair order, and under these conditions the occupants naturally present a much smarter and more "go ahead" appearance than do their "brother smuts" of the foundry. When the question of a similar equipment for the foundry arises, long tales, not of woe, but of working and other expenses are unfolded, and as for heating a foundry during the cold of winter—whoever heard of that? Certainly if the weather be extra cold the moulders are allowed to light a few kettles or "devils" and spread them over the shop, filling it with the smoke and fumes supposed to be so dear to the heart of a foundryman. But for actual heating appliances, where are the British foundries so fitted? And as for sanitary or lavatory accommodation, the foundries of Great Britain will not compare with those of the cousins over the water.

But I do not thus disparage all British foundries, having had experience in a few which might be termed "model foundries," and my recollections of these establishments are always pleasant. In them the men were of much higher calibre than is generally the case, the conditions favoured the production of good work, and the general atmosphere was one likely to develop and utilise the latent powers of each individual. Such a feeling is well worth encouraging, and if it can

Mr. Longmuir's arraignment of foundry practice for its relative backwardness, though directed first against British works, has quite too-general appropriateness everywhere. The few establishments which have treated this department with the same progressiveness and broad understanding of economy which pervade their machine shop or their power plant, stand out as shining examples—but not always as widely useful examples, as they are not in all cases willing to be studied in this regard, desiring rather to hide their light from the public eye.

The notable examples from which the illustrations of this paper are drawn show how much can be done to bring up the efficiency of the foundry and the standing of the foundry worker to the level of the machine shop. The field is one which will amply repay study and interchange of experience. A free exposition of it will be generally beneficial, and *THE ENGINEERING MAGAZINE* will welcome to its pages the discussion of problems of foundry practice.—*THE EDITORS.*

be brought about by the investment of a few pounds in making our foundries more congenial, surely the money is well spent, whilst the return is almost sure. Progress is all the cry nowadays, but on looking over the record of foundry work for the last few years, what real advance may be noted? We have newer types of cranes, electric and hydraulic, and more efficient varieties of moulding machines. The chief advance in furnace construction lies with the steel founders. An American open-hearth furnace of to-day, with its mechanical charging apparatus and fittings, cannot be otherwise described than as "up-to-date." It is in the general foundries, not having many specialties to encourage the fitting up of special plant and tools, that the least advances have been made. This is to be expected, and it does indeed seem a hard matter, with constantly changing work, to devise plant that shall meet these changes and yet be ever of the latest type. The purposes of this article, therefore, are to give a rough indication of the present condition of foundry matters and the lines on which a possible advance may be made.

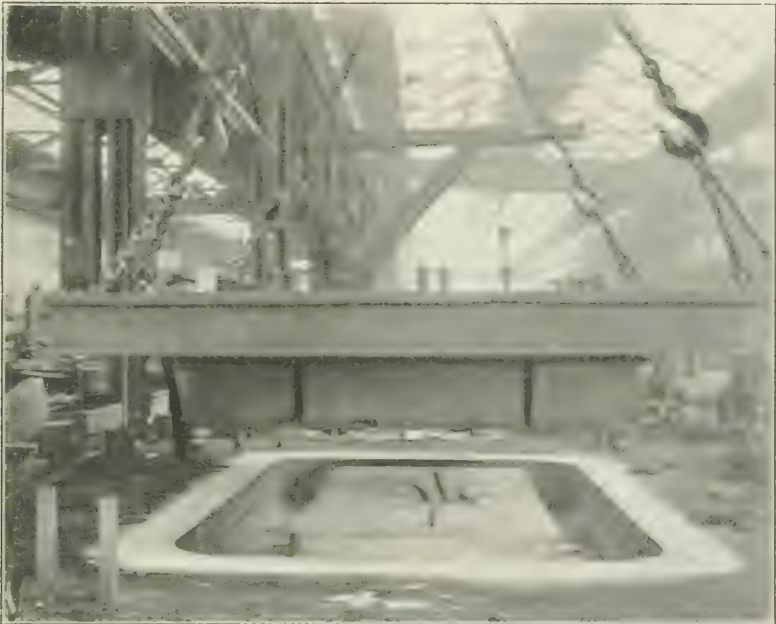
In many respects the jobbing foundries of yesterday differ but little in the matter of tools and method from those of to-day. The cupola, generally an old funnel or boiler shell lined up and seldom possessing more than two tuyeres, gave fair results and the fuel ratio was not greatly in excess of that of modern ones. They were efficient tools and gave hot metal of a fairly uniform composition at a fairly quick rate. Brass-melting furnaces were the familiar crucible and reverberatory, natural draught in each case being employed. Steel castings are of a comparatively recent date, but the earlier ones were all cast from metal melted in crucible furnaces.

General moulding appliances have not undergone much development. Boxes and moulding tools are the same, as well as the lifting tackle, slings, beams, crosses, etc. Therefore, although the founder of old had much against him, he was in many respects no worse off than his modern brother. He had the further advantages of a less-keen competition and specifications of a much more lenient nature than those we have to meet.

Chemical analysis did not in the early days play a very important part in foundry work. The purchase and grading of pig iron by fracture only resulted in a school of men remarkably expert in judging and reading these fractures. But the fracture of a pig iron, as every founder will admit, is affected by the initial temperature and also by the rates of casting and cooling. The deceptiveness of a fracture and the many failures resulting from such judgment turn us toward chem-

ical analysis, and the modern founder will grade and purchase his iron only on the result of such analysis.

In the steel foundry analysis is a recognized institution, and the day is fast approaching when such will be the case with the iron and brass foundry. The various kinds of metal will be judged and graded by analysis, chemical and mechanical only. The sulphur and ash of a coke will be estimated, the alkalis of refractory materials determined, and the amounts of these elements present will give the founder definite data as to their value and the extent to which they may be used.



THE CRANE LIFTING COPE ONTO HEAVY SWIFT MOLD, GENERAL ELECTRIC COMPANY'S FOUNDRY.

There has been a great advance in the requirements castings have to meet. The high-speed engine and high-pressure boiler are responsible for this advance, and the specifications for the castings required in the construction of these engines and boilers are necessarily of a somewhat stringent character. In tenacity, average gun metal has to show an ultimate breaking load of from 12 to 14 tons per square inch and an extension of 8 per cent. on a 2-inch length. The requirements of bronzes vary, but the average is about 17 tons per square inch in tenacity with an extension of 15 per cent. on a 6-inch length. Bars 1 inch diameter by 8 inches long are expected to bend parallel over a 2-inch radius. Steel castings are required to show a tenacity of 28 tons

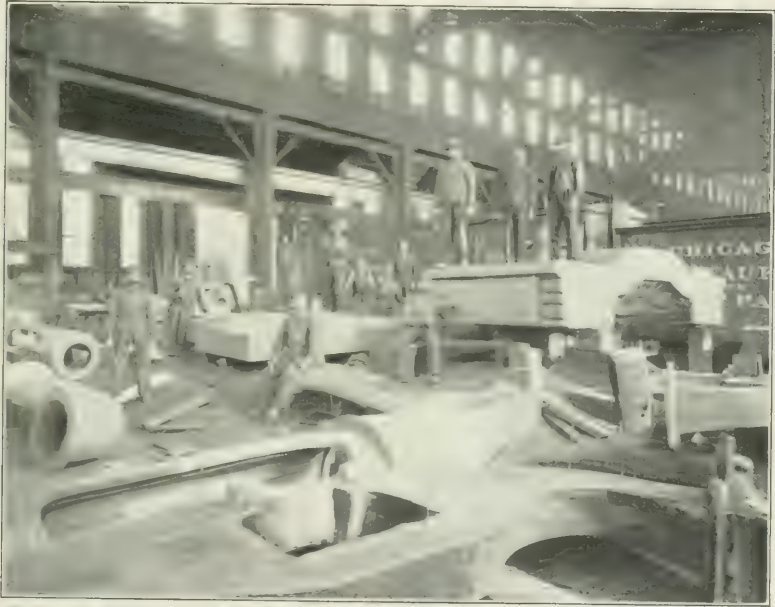
per square inch with an extension of 13 per cent. on a 2-inch length. Bars for bending tests have to bend through an angle of 90° . Cast iron is required to show a tenacity of 10 or 11 tons per square inch. In the transverse test a bar 2 inches by 1 inch, supported on centres 3 feet, must carry a load of 30 hundred weight on section before breaking. In addition to these mechanical tests, castings for steam or water pressure have hydraulic and steam trials at much higher pressures than those at which they are expected to work.

To enumerate under separate headings all the work of an iron, steel, or brass foundry would be beyond the scope of this paper: therefore only an outline will be attempted. Starting with the iron foundry, it would indeed be a hard matter to say what the work of such an establishment does not comprise. A rough grouping would give us foundries engaged on engine, marine, and jobbing work, and also the specialty shop. The latter—that is, the foundry devoted exclusively to one class of work—is the one which pays, and with proper management pays right royally. In it we can put the latest and most efficient plant; special tackle can be designed for repeat work, which will materially help to lessen the cost of production. Plant of this kind once installed can be used to advantage and made to give a good return on its outlay. This is by no means the case in the engine or marine foundry. Here the work is constantly changing, little or none of it being standard, and as a result the plant and tools are designed to be of a general rather than a special use. In itself this is crippling, and the character of the work prevents the greater adoption of labour-saving devices. The marine foundry offers many fine examples of the moulder's art, for so it may be termed, and the mention of cylinders, condensers, propellers, and the like convinces us that the moulder's trade, if not an art, is at any rate one of the most difficult of all trades associated with engineering practice. The engine foundry has in many respects a class of work similar to that of the marine.

Reference has already been made to hydraulic testing, and the iron foundry meets with its share of wasters from this test. Cylinder covers give trouble—though, often as not, faulty design is the cause of porosity. Valve bodies are often inclined to leak round the seat facing, which, by the way, is the thickest part of the casting, or round the junction of the flange and body. The flange itself may be porous and the body of the valve tight, as shown when the water percolates through one of the stud holes. To overcome these difficulties some knowledge must be attained of the work and the mixture of iron arranged to meet these requirements.

These requirements vary, but the varieties of pig and scrap in the mixture must be apportioned to give the result individual experience would indicate to be the best. A further point is the temperature of casting, and here again individual experience must be the guide.

The work of a jobbing foundry is, to say the least of it, varied. Castings may be made in it ranging upwards from sash-weights and open sand plates to engine-bed plates and cylinders. Loam, dry sand and green sand may be in progress all at the one time and in various parts of the shop. The appearance of such a concern, to an outside eye, would be one of hopeless chaos. Nevertheless very fair castings are made in these establishments, and undoubtedly they are the best training ground for our moulders, for the experience gained in them is both varied and extensive.



CHIPPING ROOM, E. P. ALLIS COMPANY'S FOUNDRY, SHOWING THE HEAVY ENGINE WORK TURNED OUT

The work of a brass foundry varies according to environment: it may be a specialty shop engaged on valves only, possibly on one type of engine work, or it may be doing general engineering castings. The variety of work in the latter establishment may be gathered from the fact that the metals used range from copper to aluminum, the alloys include various qualities of brasses, gun metals, bronzes, and white metals. The bearing brasses made in this establishment range in size from those required by the shafts of a large battle-ship down to the

main bearings of a small fan engine. A rough survey of the articles made by an engineering brass foundry would include condenser casings, stern tubes, shaft liners, propellers, bosses and blades, stem and stern-post fittings of a cruiser, engine, boiler, and ship's mountings, and the brass castings required by the electrical and plumbing departments.

The high initial melting point of steel, its liability to occlusion, and the high contraction coefficient, render extreme care necessary in manipulating the metal or in making the mould. The moulds vary from stern posts and pump rods upwards of 40 feet in length down to the small fittings required in the construction of a bicycle. Many engine details are cast in steel; these include pistons, cross-heads, eccentric straps, main bearings, and cylinder covers. Bed frames and columns for the marine engine are cast in the steel foundry. Spur and bevel gearing of all types is made in varying sizes. Small castings for high-class bicycle and motor-car details are made in steel. For average work, similar castings are made in malleable iron. Dead mild steel castings for electrical purposes are in an increasing demand, and if steels of greater magnetic permeability can be commercially produced this field of work will be an expanding one. Steel castings hav-



FOUNDRY OF THE E. P. ALLIS CO., MILWAUKEE, U. S. A. MOULD FOR 24-FOOT ROPE WHEEL IN FOREGROUND.



MOULDING BED-PLATE FOR 7,000-HORSE-POWER ENGINE, FOUNDRY OF THE E. P. ALLIS COMPANY.

ing a water test to meet comprise hydraulic cylinders, tees, pipes, bends, stop valves, and boiler connections. As is the case with cast iron and brass, many failures on this test are due to faulty or ill-proportioned design. Apart from errors of moulding or melting, there are severe contraction strains which in not a few cases are responsible for the leakage of castings. Many forms of steel castings are liable to warp, technically known as "pulling." A casting so distorted gives not a little trouble in "setting," and much of this work can be saved if the patterns are set out of truth to the extent of the "pull." This can only be accurately done by working on the result of many observations of warping and contraction. In some cases steel castings seem to vary in their warping tendencies for mere "cussedness," and therefore a fixed rule that would meet the majority of cases can not be laid down. As is well-known, all steel castings require a subsequent annealing. Much of the after success of the casting depends upon the thoroughness of this annealing.

The material of which a mould is constructed must allow the free passage of air and gases generated at the moment of casting. It must be firm, and sufficiently compact to withstand the pressure of the liquid metal. It should be capable of withstanding the high temperature

without fusing, and be readily removed from the casting, to which it should give a clean, smooth skin.

Moulding sands consist essentially of silica, with more or less magnesia, alumina, lime, and certain metallic oxides. The presence of these metallic oxides and lime, if in excess, seriously impairs the refractory qualities of the sand. Magnesia and alumina act as binders, silica increases the refractory qualities, but when in excess does so at the expense of plasticity.

The quality of a loam varies with the locality, and in addition to this most foundrymen have a pet theory of their own in mixing up loam. It is, or should be, specially ground for each particular class of work, and consists of various qualities of sands ground to the required consistency under edge runners. To this are added varying amounts of either hair, hayseeds, or dung. The best loam, and one that rarely "scabs," is made from sharp sand and clay, the latter being added in sufficient quantity to give the requisite cohesion to the loam. It is ground in the usual fashion under edge runners.

The mould for a steel casting, owing to the high melting point of this metal, must of necessity be of a very refractory nature. To meet this, silica sands in conjunction with binding materials are used. There are many compositions technically known as "comps" in use. These consist of old clay crucibles, fire-brick, or similar refractory material, ground to the required fineness and mixed with various binding agents.

Whilst on the question of sands it may be well to state that a mould for brass or gun-metal should be in a much dryer condition than one for iron. An iron-founder's sands may be coarser and his moulds more moist than a brass founder's, for the reason that the heat-conducting powers of iron are much less than those of the copper alloys.

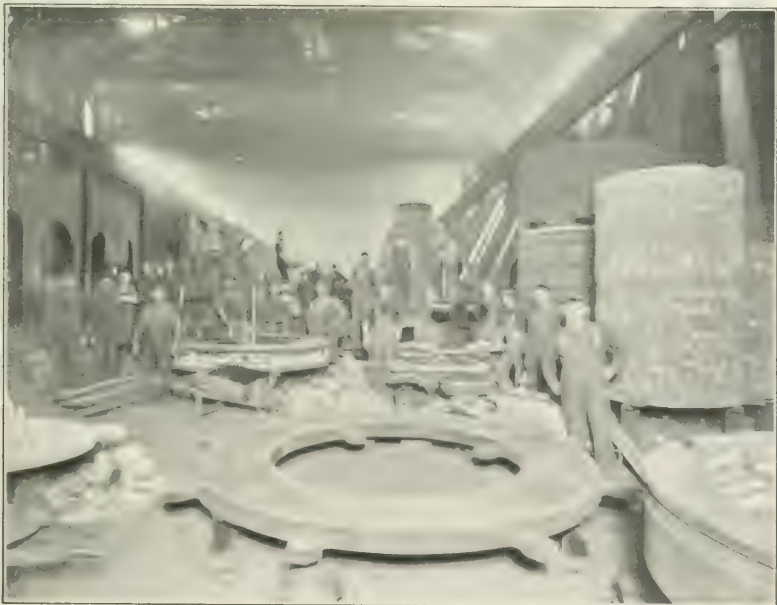
From a consideration of the sands we come to the crucial question of their use and of the appliances that facilitate this use. Many methods have been devised to increase the turn-out of a foundry, especially so with light repetition work. In much of this class of work the only way in which a fair profit can be made is by the most minute attention to detail. It is not a question of hours, but rather of saving minutes, and often on a large order the minutes so saved turn the scale between profit and loss. It therefore behooves foundrymen to give this question of minutes the greatest attention, and any contrivance that will lessen the cost of production, even though trifling, should be adopted. But it must be remembered that the aim of any such contrivance is to lessen nett cost, and not, as do so many system plans and

machines lately brought forward, actually *increase* nett foundry cost of production.

All patterns should be finished as well as circumstances will allow, suitably halved, and all loose pieces dovetailed on. The pattern, when it leaves the pattern maker's hands, ought to be complete, no corners, fillers, or the like left to the moulder to cut, for when the moulder has these alterations to make they are apt to look clumsy and be irregular. After each day's work is put down the patterns can be polished with bees' wax or similar material. This plan is followed in many malleable-iron foundries, and it lengthens the life of the pattern in addition to keeping it in good working trim.

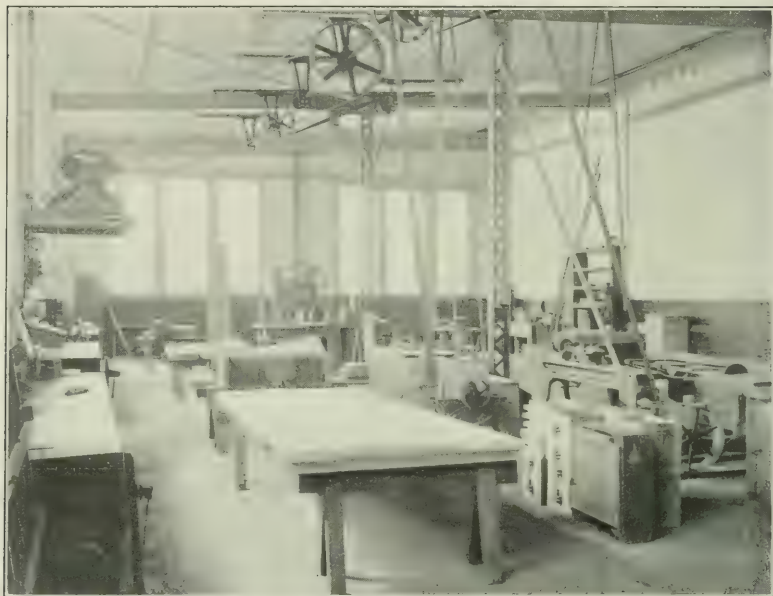
The moulding boxes for small castings should be fairly light, easy to handle, and members of each size should be interchangeable one with another. Joint faces are planed or milled true, whilst the pins are either tapped into the snug or turned with a shoulder and fixed by a nut below the snug. Rivetted pins are apt to work loose and a loose pin, to the founder, should be "*un bête noir*."

In many foundries valuable time is lost in searching for material, tools, etc. The best that can be said for such a condition is that it shows a lack of organisation. Every box ought to have its fittings complete, bottom boards or plates, if used, runner cups, weights, etc.



LOAM MOULDS, E. P. ALLIS FOUNDRY.

A suitable form of weight covers the whole of the box, the recess taking the runner. It prevents any straining or "run outs." Each moulder ought to be fitted up with his own tools, as shovel, rammers, sieves, brushes, and bellows. Further than this, he should be held responsible for their proper use and safe keeping.



FLASK ROOM, GENERAL ELECTRIC COMPANY'S FOUNDRY, SCHENECTADY, N. Y.

"Oddside" moulding is largely practised in brass and malleable-iron foundries. The oddside may be of sand, where only a few boxes have to be made with it, or, in the case of larger orders, it may be of plaster, cement, or any of the compounds specially prepared for this purpose. Its object is to save making a joint each time of moulding. In many cases the quantity of castings required will warrant the casting of a full set of patterns with runner attached. This, if nicely finished off, will hasten the operation of moulding, as the whole set of patterns are in one and, if the oddside gives clear joints, little or no tool work is necessary in finishing the mould. Even when the patterns are worked loose it is advantageous to have a gate or "runner" pattern. These runners, arranged to suit the job, save the moulder trouble and ensure a gate of the right size in each casting.

Plates for plate moulding are of two types—plate and pattern cast all in one piece, or the patterns suitably divided are mounted on a planed plate. The latter is perhaps the better plan, for by it the half-

patterns can be machined up true. It is a fairly easy matter to mount them, with runners to correspond, on the flat plate. With a cast plate very little machining can be done; consequently all the finishing is hand work—a rather expensive operation. Plates may be fitted up entirely of wood, though at the best this is but a primitive method and one not to be recommended. Both plate and oddside moulding permit the use of snap flasks. Adjustable pins allow for wear and are always worked to give a true fit. When the completed mould is put down for casting the flask is unbinged and lifted away, in one sense acting as a core box, the mould being the core. Weights used for “snap” work must cover the whole of the sand, and for deep castings having a tendency to burst the mould, binders should be used. These binders are of light cast or sheet iron and are rammed up with the snap. They keep the sand firm against a side-pressure and hence their use for deep work. The ends of the rammer may be protected with a face of light iron, or they may be tipped with hide—preferably the latter. For cleaning loose sand from the moulds, flexible pipes attached to a blast main or compressed-air supply are handier and more efficient than bellows.

The introduction of mechanical appliances for moulding has in many cases met with great success, notably in specialty work, as gearing of all kinds, or machine and other castings in which there is a demand for standard sizes. The castings required in the construction of sewing machines offer special advantages to the introduction of mechanical work—advantages which are realised to the full extent by few firms in Great Britain. Many useful hand-moulding machines are to be had—though “machine” in its full sense is hardly a correct term, for the only mechanical function is that of drawing the pattern plate from the mould. Stripping plates, if used, ensure a clean part and give a mould with no broken edges. With certain of these machines loose patterns can be arranged on an oddside, and in the case of small orders thus save the expense of a pattern plate. Drawing a pattern through a stripping plate is a simple operation, hence the introduction of an inexpensive class of trained labourers in place of moulders to operate them. The ramming, venting, and finishing of a mould is practically the same with hand-machine as hand-plate moulding, a fact often overlooked by the advocates of this class of machine moulding. The prime movers in use for operating moulding machines comprise hydraulic, pneumatic, and steam powers. Good results have been obtained with hydraulic power, and machines so operated have been installed with more or less success in many engineering and specialty foundries. Power machines are made to take a standard-size

box, or if not, the box is part and parcel of the machine, and the mould, when completed, is pushed up through the box by means of an inner ram. In this case bottom plates and binders are required, the former of cast iron for lifting away the mould, and the latter of light cast or sheet iron to sustain the mould against the casting pressure. A moulding machine to be really successful must be specially designed for the



SWEEPING A MOULD FOR A HEAVY FLYWHEEL, FRASER & CHALMERS FOUNDRY,
CHICAGO, U. S. A.

castings it is intended to produce, and, further, it must be kept on this particular class of work only. The failure and consequent condemnation of many machines is due to the view that works managers—whose knowledge of foundry matters is as a rule limited—have taken that such tools are universal. This is absolutely the last sense in which a moulding machine should be regarded.

In sand moulding much can be done independently of machines to cheapen cost of production and facilitate the turn-out. Many castings made in dry sand could with the introduction of suitable cores be made in green sand, often resulting in a saving of pattern making as well. On the other hand, many castings made in green sand would, if dried, be made much cheaper. A strong factor in favour of dry-sand work is that the risk, always a very present element in the foundry, is con-

siderably diminished. Pattern making in the case of circular or semi-circular castings can to a certain extent be saved by the use of sweeps and strickles. A familiar case is that of a fly-wheel, the rim of which is swept up in sand whilst the hub and arms are formed with cores. A covering cope is swept from the same centre. Spur wheels are made in a similar way, segment cores forming the teeth. An extension of this principle is the wheel-moulding machine, which may be of a portable or fixed design. A method of core making often adopted with elbows and pipes of irregular form is to make the core in the mould by thickening it—that is, by laying on strips of clay of the same thickness as that required in the casting. The two halves of the mould form the core box; suitable grids are used so that the two half cores, when dry, may be bolted together. The plan will admit of extension, and in cases where only single castings are required will save the expense of core boxes.

Loam moulds can in certain cases be made to serve several times



SEGMENT-MOULDING OF LARGE GEAR WHEEL, FRASER & CHALMERS FOUNDRY
CHICAGO, U. S. A.

of casting, a good example being that of a propeller blade. After the first casting the bed is set in exactly the same position as that in which it was built, and swept; this is fairly easy to do, as the gables are not disturbed until the order is completed. The skin of the mould is broken and a thickness of facing loam swept over; on this the pattern is formed as usual with guide strips. A thickness of facing loam



DRYING MOULDS AND COPE IN POSITION BY PORTABLE ELECTRIC FAN AND BLAST HEATING STOVE, GENERAL ELECTRIC COMPANY'S FOUNDRY.

is spread over this, and the cope, which has previously had the old skin scratched away and has been given a coating of clay water, is bedded on. A similar plan is adopted with many loam castings of a simple character, and moulds for pans, kettles, etc., are often used over.

Several types of heaters are in use for drying or skin-drying sand moulds by means of hot air. Foundry drying stoves are not always the efficient tools they should be. In many cases the carriages take far too much moving, and when they do move shake the moulds far more than is good for them. Many stoves have too much waste space, and the walls and roof are too lightly built, resulting in a loss of heat by radiation. The ideal stove should be just large enough to take the loaded carriages. These carriages should run easily on well-laid tracks and offer little vibration. The firing arrangements should be such that all the heat of the fuel, whether coal, coke, or producer gas, is utilised.

A brief survey only will be attempted of the various types of furnaces used by the founder. As a rule the methods of working furnaces vary as much as the types, and hence the reason of so many old home-made furnaces giving results equal to, in many cases, some of the most

up-to-date ones. The success of a furnace lies more with the way it is worked than in design, and the best results can only be obtained by proper working and efficient management. It is a problem of no little interest as to what constitutes "proper working" and the standard by which the work of a furnace should be judged. In this respect three factors are important.

1:—Fuel consumption.

2:—Life of the furnace.

3:—Condition of metal obtained from the furnace. Many works managers unacquainted with foundry work attach far too much importance to the first condition, while the third, and from the founder's point of view the most important, is ignored. Low fuel ratios look well on paper or in the circulars of a furnace builder, but the question to the founder is how far are they really economical. Dull iron in many cases means a dirty casting, whilst dull brass or bronze may result in a drawn or porous casting. Not a few wasters may be traced to being cast at too low a temperature. These wasters, in addition to the actual loss of the casting, have a demoralising effect on the moulders and tend to develop a "don't care" method of working. It will



INTERIOR OF THE PEERING HARVESTER COMPANY'S FOUNDRY, CHICAGO, ILL.,
SHOWING REPETITIVE WORK.

readily be seen then that the fuel ratio of any furnace should be taken as that required to bring the metal to the best condition for casting, and not that required just to melt the metal. This ratio will vary with similar furnaces in different foundries and with different classes of work.

The cupola may be described as a cylindrical shaft furnace. It possesses one, or, in later types, two rows of tuyeres, which are supplied with low-pressure blast at or about atmospheric temperature. The blast is furnished by a fan or, more generally, by a blower of the Root's type. The charges of coke and iron are carried up to the charging stage by means of a lift, which is most conveniently operated by hydraulic power. The metal, as it melts, collects in the bottom of

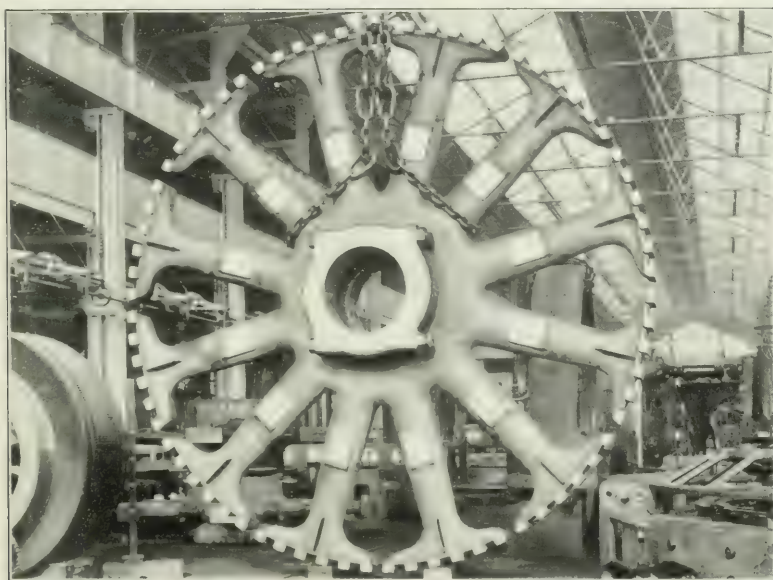


CUPOLAS, GENERAL ELECTRIC FOUNDRY.

the cupola and is tapped out at intervals, or it may be gathered in a receiver. All present day cupolas are, or should be, fitted with "drop bottoms," the utility of which any founder will recognise. The blast main should be fitted with a pressure gauge, which will assist the furnaceman in keeping his working conditions as uniform as possible.

Limestone is generally used as a flux in the cupola furnace. It

fluxes off the silica of the sand adhering to the pig iron and scrap. It also takes up any silica produced by oxidation of the silicon in the iron and combines with the ash of the coke. Latterly fluor-spar has been used with good results, and a combination of fluor and limestone is used in many foundries with excellent results. The effect of remelting iron in the cupola is, in foundry parlance, "to harden it." If the



DIFFICULT CASTING FROM THE GENERAL ELECTRIC COMPANY'S FOUNDRY—THE SPIDER OF A LARGE ARMATURE.

original iron is soft, by remelting it becomes harder and closer in grain and it may be stronger. On remelting hard cast iron, the hardness is still further increased and loss of strength the result. The physical changes brought about by remelting cast iron are indications of chemical changes in the material, which vary according to the amount of oxidation it has undergone. These changes are shown in the following table by Jüngst, of the Imperial Foundry, Gleiwitz:

	1st melt.	2d melt.	3d melt.
Graphite	2.73	2.54	2.08
Combined Carbon.....	0.66	0.80	1.28
Silicon	2.42	1.88	1.16
Sulphur	0.04	0.10	0.20
Phosphorus	0.31	0.38	0.28
Manganese	1.00	0.44	0.36

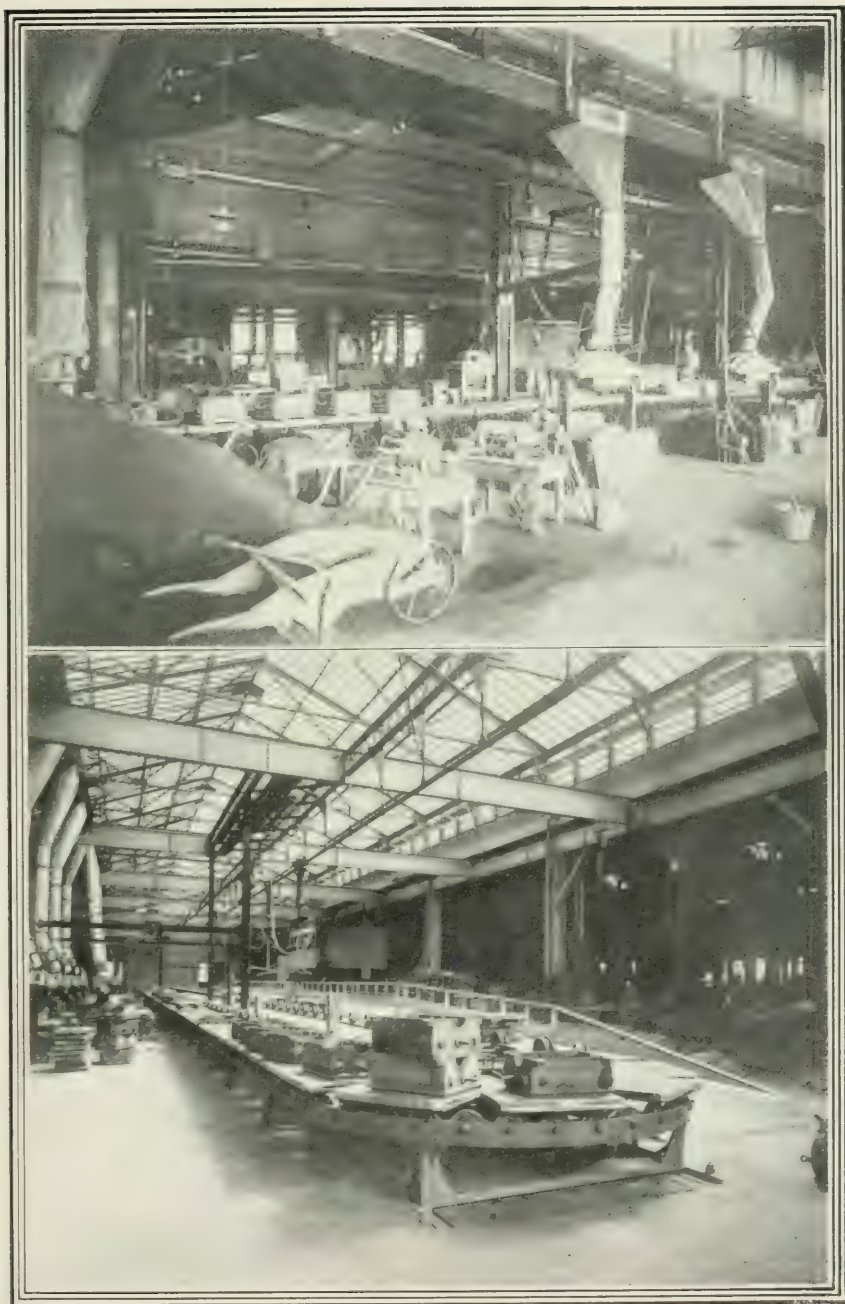
The reverberatory furnace is to a certain extent used in iron foundries for melting irons of special qualities, such as are required for

casting chilled rolls. Greater uniformity is possible, as test bars can be taken from the bath of molten metal and any addition found to be necessary made before tapping. Reducing or oxidising flames can be maintained, and hence the use of this form of furnace in malleable-iron foundries. Malleable castings, before annealing, require the greater part of the carbon to be in the combined state. This can be secured in the air furnace by maintaining an oxidising flame, which converts the free carbon into the combined state. Test bars are taken and the condition of the metal judged from the fractures shown by these bars. When used for melting brass or bronze these furnaces are worked with a reducing flame to prevent loss of zinc or other volatile metal. Even with this precaution considerable zinc is lost. The loss varies with different furnaces, but may be taken as an average of 10 per cent. This loss should be allowed for in making up the alloy.

Reverberatory furnaces may be worked with natural, forced, or induced draught. Natural draught, though slower, gives perhaps the better results. These furnaces vary considerably in design, but the greatest difference lies in the lines of the roof. The work of this roof is to deflect the flame onto the hearth of the furnace, and the amount of this deflection determines the utility of the furnace. The fuel used should be a good flaming coal of the bituminous non-caking variety. Producer gas has been applied to these furnaces in malleable-iron practice, and this fuel should be capable of still further adoption.

Crucible furnaces, as used for melting steel, brass, bronze, or iron for malleable castings, are all more or less of one type. They vary most in sizes and in arrangement of flues, stack, etc. Steel furnaces are generally oval and arranged to take two crucibles. The "holes" are formed of ganister, which is rammed around a wooden pattern the shape of the fire. They are usually relined once a month, all the furnaces in the row being done on the same day, which day is technically termed "building day." The crucibles used seldom contain more than 70 pounds, generally from 50 to 60. They are made of various mixtures of fire clay, and their life is represented by one day's work of three heats.

Crucibles for melting brass or bronze are made from mixtures of fire clay and plumbago and will stand from fifteen to forty heats. The life of the crucibles depends upon the class of alloy melted, the temperature to which the crucible is heated, and the care used in handling. They vary in capacity from 15 to 600 pounds of metal. The heavier sizes necessitate the use of mechanical appliances to "draw" the crucible from the fire. One crucible is used with brass furnaces and the



WESTINGHOUSE AIR-BRAKE WORKS, WILMERDING, PA., U. S. A.

Two views in the foundry, showing the travelling table. The mechanical equipment is probably the most highly-specialised in the world.

fires are circular. They are built of good fire-brick, which as it wears is patched with ganister or fire clay. Many brass-melting furnaces consist of a cast-iron shell lined up with ganister. Stock shells are carried, all lined and ready for fixing in position, and when a furnace needs repairs the old shell is hoisted out and a stock one placed in.

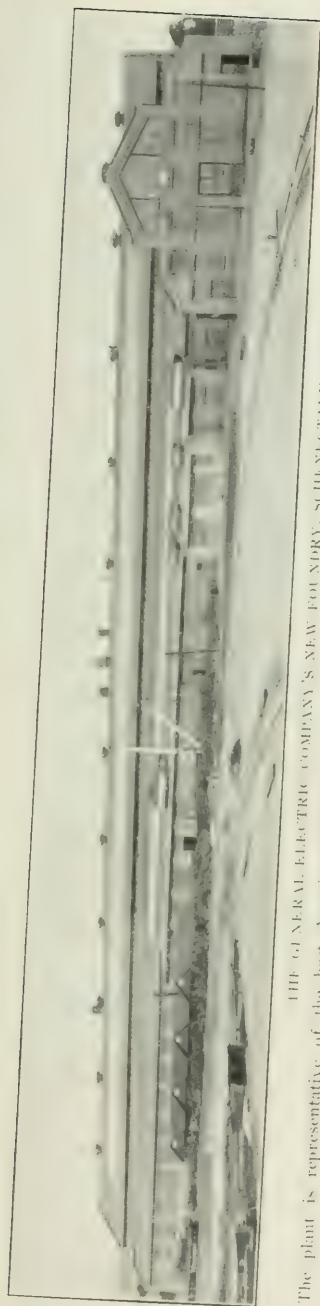
Continental brass-melting furnaces of the Rousseau and Piat-Baumann type are much in advance of British ones, especially as regards the fuel consumption and life of the crucible.

Crucible furnaces, heated with gas in place of solid fuel, have to a certain extent been adopted. The advantages of such a fuel are that



INTERIOR OF THE GENERAL ELECTRIC FOUNDRY.
Showing travellers and jib cranes.

the temperature is under much better control, there is greater cleanliness, and an oxidising, neutral, or reducing atmosphere can be maintained at will. Gas furnaces are not so severe on the crucibles as are furnaces fed with solid fuel, and therefore the life of a crucible under such conditions is much longer. For crucible fires the Siemens regenerative system is generally adopted, and is in many respects similar to the plant in use with open-hearth furnaces. A producer of the Siemens or Wilson type will permit of inferior fuel or slack being used. A reducing or neutral atmosphere can be readily maintained, thereby preventing a loss of metal by oxidation. This is an undoubted advan-



THE GENERAL ELECTRIC COMPANY'S NEW FOUNDRY, SCHENECTADY, N. Y.
The plant is representative of the best American foundry practice. The ample lighting is especially noticeable, wire glass in the roof being added to the double eave-story. It is electrically operated throughout.

tage when it is necessary to preserve the composition of the alloys intact, as is the case with brasses and bronzes.

In designing a new foundry an expert founder ought to be consulted, and not, as is generally the case, brought in at the eleventh hour, when all the plant is laid down and the foundry ready for starting work. The heating, ventilating, and lighting arrangements should be up to the same standard as is usual in other departments of an engineering works. It is hardly necessary to urge the importance of a good and free light supply, and indeed the difficulty is to find an excuse for the gloom and dinginess of many foundries. That the roofs should be weather proof goes without saying, but a survey of many foundry roofs in wet weather is not very convincing as to their power of resisting the percolating action of water. With regard to ventilation, there is usually plenty of it in the winter months and a scarcity in the summer, which lends colour to the definition of a foundry being a hot, smoky hole in summer and a cheerless, dismal one in the winter. The arrangement of a foundry will naturally be controlled by the class of castings required from it. Separate buildings are the best for the different metals, though there are cases in which steel and iron or iron and brass are successfully worked under the one roof. A further controlling factor will be the proportion of green and dry-sand to loam castings. Distinct divisions should be devoted to each class of work, and the various tools and materials required by green or dry-sand and loam moulders kept in their respective divisions. An

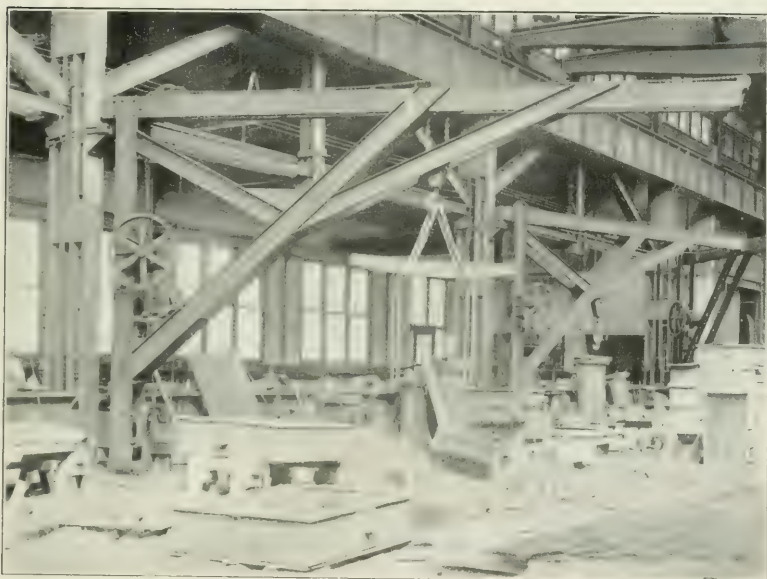
extension of this system is to divide out the floor into convenient spaces, say the ground covered by the sweep of each jib crane, keeping one class of work and all the tools required for it in the space reserved. By this system no man need leave his own locality and there is no excuse for a man wandering up and down the shop looking for tools or boxes. In not a few foundries as much as one-sixth of the working time is spent in waiting for lifts, looking for materials, boxes, etc.,



USING PNEUMATIC LIFT IN POURING. DEERING HARVESTER COMPANY'S FOUNDRY.

which when found often require putting in order or repairing. The facilities for the entrance or dispatch of materials should be of the best, and not of the kind so familiar—that is, everything coming in and out on the one narrow-gauge track. Such a system in a busy foundry gives rise to many delays. The method of stacking boxes in the yard should be such that any box can be reached with little delay. Oftener than not the stack of boxes resembles a scrap pile more than

anything, and it is no wonder that with such a lack of system the time taken to get a box runs up to half a day. The question of the most suitable lifting appliances for foundry work is one rather open to discussion, but probably the best arrangement is an overhead traveller electrically driven, and hydraulic jib cranes on the wall posts or columns below. The traveller should be of sufficient power to take the heaviest loads, whilst the jib cranes could be of a lighter type, and be used for lifting off boxes, drawing patterns, and putting in cores. A

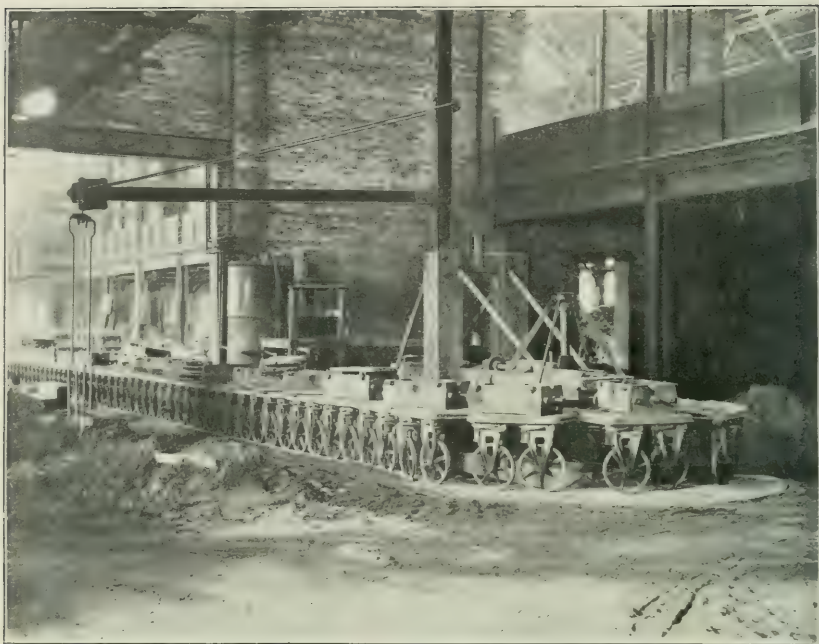


MOVABLE JIB CRANES, GENERAL ELECTRIC COMPANY'S FOUNDRY, SCHENECTADY, N. Y.

Almost every post has pintles fitted to receive these cranes. The traveller can be hooked into a loop at the top of any jib, which can then be carried where wanted, dropped over another set of pins, the electric switches snapped into place, and the jib crane is again ready for work.

travelling crane alone is almost useless, for in the majority of cases fully half the men stand waiting for lifts, most of which are of light loads. One traveller supplemented with jib cranes is preferable to two travellers on the one set of rails. Where much machine or light moulding is done an overhead trolley track is convenient for carrying the metal and casting.

The aid of chemical and mechanical analysis has been referred to earlier, and in the ideal foundry of the future this aid will be fully recognised. To operate a foundry of to-day an exact knowledge of work-



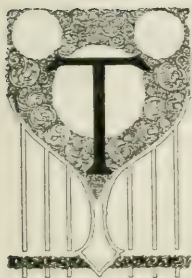
FLASK CONVEYOR IN THE WESTINGHOUSE AIR-BRAKE COMPANY'S FOUNDRY.

The plant is at Wilmerding, Pa., and is used in connection with moulding machine and cupola. Flasks from the machine are placed in the carrier, 225 ft. long, conveyed to the cupola for pouring, and, cooling in transit, are shaken out at farther end of foundry. Link-Belt Engineering Co.

ing conditions must be attained, and the man working such a foundry must have a fair knowledge of the crystallisation and contraction of metals. In addition to his practical knowledge he must be acquainted with metallurgy as far as it affects the metals he uses. Dividing the responsibility between chemist and foreman has not proved a success, and it now remains for the foreman to acquire the scientific knowledge necessary to his branch of foundry work and in which he has unlimited opportunities of applying it. Such, then, should be the qualifications of the head of a foundry of to-day—a man with practical and theoretical training combined; one who can manage men wisely and instill into them the desire of producing efficient work. Such a man would be up-to-date in every respect, and he should be given full control and allowed free scope for his inventive powers. Run on these lines, and with a head master of his business, the foundry as a profit maker will vie with any other department of an engineering establishment.

THE PRACTICAL MANAGEMENT OF MINING OPERATIONS.

By John E. Hardman.



THE mine manager may be called upon to commence his duties with the deposit of mineral practically untouched, or in the condition known in the western States as a "prospect," but usually he assumes his duties after a property has passed its prospect stage, and has been developed sufficiently to afford the data which are necessary to prove beyond reasonable doubts that the deposit of mineral has both sufficient size and sufficient richness to be worked at a profit. If this preliminary work has not been done, the first duty of the manager is to satisfy himself that these necessary factors exist. In the early development of a mine there is but one hard and fast rule and that is, to "follow the ore," no matter how irregular its dip, strike, or general characteristics may be.

It is assumed that there is a record of all previous excavations and tests, of the eccentricities and irregularities in the ore deposit, of whether pay values are confined to "chutes" or are disseminated throughout the matrix, of the amount of water coming into the mine, of the nature and character of the walls of the deposit, of their tendency to "weather," "swell" or otherwise, of the permanence of openings made in the "country," and that, either from previous operations or from the manager's preliminary work, all the facts requiring consideration before beginning permanent works are ascertained or recorded.

A plan and several sections of the property should be prepared with the contour of the surface laid down in lines not over 50 feet apart vertically. These drawings should show the extent or longitudinal dimensions of the deposit, its various widths, as ascertained

Mr. Hardman very properly remarks that the space available in a magazine article does not permit of going into explicit details, but is sufficient only to present the outlines of the practice which should lead to success—that his summary is simply the skeleton, "from which it is frankly admitted many of the smaller bones are missing." The study of anatomy, however, is based upon a thorough knowledge of the skeleton. It is necessary to take away the enveloping fabric and make clear the framework. His paper is thoroughly practical and scientific in revealing the solid structure upon which the body of successful mine management is built up.—THE EDITORS.

both on the surface and underground, the variations in dip of the lode, the trend of the ore chutes, the faults which dislocate the ore body, and such other data as may be known from previous workings. The manager can then determine approximately the daily quantity of ore to be mined, which will help to determine the size of the openings required, the character of the hoisting machinery, and the number of men that can be employed to advantage. With this mapping should be associated a careful assay sheet, so that the pay chutes (if the pay ore is confined to chutes) may be roughly located and their angle of dip known, also their average width and length in the vein. All these data should be carefully noted and used as the basis of determining not only the probable output of the mine when working as a going concern, but also as influencing the location and character of the main openings to be made upon the property.

These tests, or the data they afford, may be regarded as absolutely indispensable before a purchase of the property is made, so that its valuation may be approximated as closely as possible; for one of the principles governing the acquisition of a mining property may be clearly stated as follows, viz.: Does there exist on the property a deposit of mineral of sufficient size and richness to repay all costs incurred in (1) purchasing the property, (2) erecting a plant of sufficient size and capacity to properly work the deposit, (3) to repay all capital expended in development (*i. e.*, in sinking, driving, erecting surface works, etc.), (4) to repay the capital required to cover all transportation charges, either to a public market or public reduction works, or to the company's own reduction works, and (5) last, but by no means least, to yield, after repayment of all these items, a good return or interest on the capital thus employed? Not only must the original investment be repaid, but while it is repaying it must earn a satisfactory interest; it may be pertinent to say that some of the ablest engineers on the American continent consider that the yearly interest on capital invested in metalliferous deposits should never be *less* than 10 per cent., and that 15 per cent. is nearer a just compensation.

With the results of this preliminary work just mentioned should be united a knowledge of the geological structure of the district immediately surrounding the deposit, or "the rule of the camp," as it is called, as shown and proved by the workings of adjacent mines.

The preceding investigations having shown that there exists a profitable deposit of sufficient magnitude to warrant systematic working, the manager will proceed, after consideration of the data ascertained and of the facts available, to consider the main plan of attack, or

of development, for the property. The requisite and proper plant of machinery for such workings, and the determination of whether it is advisable (due regard being paid to the financial condition of the company and the length of time required fully to open the property) for the company to mill, concentrate, or reduce its own ore have also to be considered. The topography and physiography of the property will indicate whether the deposit can best be opened by a vertical shaft or by an inclined one; by an adit upon the vein, or by a cross-cut tunnel. The choice of method having been made, it is necessary to determine the location of the principal outlet from the mine, *i. e.*, the mouth of the shaft or the entrance of the main adit or cross-cut tunnel. The considerations determining this location depend upon the character of the deposit to a very great extent; *e. g.*, whether the deposit is a free-milling ore which can be sent at once to the company's own mill, or a refractory gold ore requiring cyaniding and subsequent treatment of concentrates or vanner heads; whether such sulphuretted concentrates are to be treated by pan method or by chlorination, *etc.*; also whether the ore is a concentrating one which is to be delivered to the company's own dressing mill or concentration works, or whether it is of sufficient grade to ship at once to a smelter; next, if it is a smelting ore, whether it is sufficiently free from silicious and earthy matter to be smelted or shipped at once, or whether it requires preliminary dressing (by cobbing and picking, or by fine concentration) before shipment is made to the market. These various and varying possibilities require careful consideration, as they influence the selection of the site for such dressing and reduction works, so as to reduce the handling and transportation to a minimum. With these matters must be associated the determination of other factors, such as the amount and cost of water available for dressing works or for milling purposes; whether the source of power is to be water or steam, and in the case of water, whether the same is at hand or whether the power from it is to be transmitted, and if so, whether by electricity, compressed air, or otherwise; whether the fuel is to be coal or wood, or petroleum. From consideration of the preceding items the location of the main mine opening and of the surface plant can be determined upon.

The preliminary exploration referred to has given the location and pitch of the pay chutes, the dip of the vein, its lateral extent, and the probable amount of ore which can be won as a daily average. With these data at hand the manager can decide whether to make his permanent working through an inclined shaft, or whether (for reasons of future costs) it is advisable to sink a vertical shaft, located with

proper reference to the dip of the vein and of the pay chutes. It is noted that the practice (formerly prevalent in America) of sinking inclined shafts has already been abandoned in many of the large mining centres in favor of vertical shafts. Notably is this the case in the Lake Superior copper country, in the district around Butte, Montana, and also in the older counties of California. Perhaps the most striking instances are in California, in the counties of Amador and Calaveras. In these sections, several properties which, forty or fifty years ago, were worked by means of inclined shafts are now reopening (or have reopened) with vertical shafts, *e. g.*, the Kennedy, Oneida, South Eureka, and Wildman-Mahoney mines in Amador county, and the Gwin and Lightner mines in Calaveras county. In these instances vertical shafts have been chosen for permanent attack upon veins which were previously opened and worked by inclined shafts; after abandonment (in many cases for years and years) these same properties have been reopened and a second era of profitable existence begun through the sinking of vertical shafts from which cross-cuts have been made to the vein, and with such pecuniary results as have been most pleasing to the shareholders concerned.

The notable success, as managers, of American mining men over mining men of other countries is in quickly and successfully solving the problem: Given a certain sum of money locked up in a certain piece of ground, how can that money be extracted in the shortest possible time at the cheapest cost? A mine is nothing more nor less than a certain amount of money locked up in earthy material; the more quickly that money can be taken out the less interest will have to be paid on the capital invested to take it out, and the sooner the profits realized can themselves be turned into interest-bearing sums. It follows logically that the more quickly a mine is developed the sooner extraction can be begun.

Underground workings, such as shafts, levels, stopes, etc., all have as their ultimate object the making of this extraction as rapid and as cheap as possible. There are, of course, other factors which it is necessary to consider, such as the safety and health of the workmen employed, and (in some cases) the preservation of the surface of the property in undisturbed condition. The carrying forward of these various branches of underground work in the proper way is one of the important duties of the manager, who may delegate the immediate supervision to his foreman, but who, nevertheless, is himself responsible both to his employer and to the law.

In the sinking of shafts, as in almost all other underground devel-

opment, it is advisable that such work should be done by contract rather than by day's pay. The reasons for this are manifest. The main factors involved are those of labor and time; and it is an axiom that a man working for himself will do a greater amount of work in a given time than one working for an employer; it is equally axiomatic that a workman who pays for his supplies will use greater economy, and make a given quantity go a longer distance than when the company furnishes them. Similarly, a greater care of the machinery used for removing rock and water is observed on contract work than on day's-pay work, for the reason that damages are charged directly to the contractors, if any occur.

Since a manager's tools are chiefly his professional ability, his knowledge of general business and of men, one of his first duties is to obtain a good underground foreman. The selection of a foreman is a paramount consideration; the foreman should be chosen for his experience and his record as an economical worker, as well as for his capacity in handling labor. The latter qualification is one which is natural to some individuals and impossible to others, and a foreman who has this faculty can easily acquire the necessary experience and the record in a comparatively short time. The benefit of choosing such a man from the ranks of the workmen is considerable; he has a knowledge of men's likes and dislikes from themselves, and knows also their actual worth. Such a man has the prestige of being "one of themselves," as it were, and they recognize his superiority from the fact that he has been chosen to do work which is above them; they also know that they can not deceive him as to their work.

Economical sinking depends upon a factor which is often overlooked, viz., that as much attention should be paid to "mucking," or means of taking broken rock away from the miners, as to the facilities afforded such miners for breaking the rock. It is notable that a very large part of the success which attended the sinking of the vertical shafts in the Lake Superior region, particularly at the Tamarack mine, was due to the very complete arrangements made for the mucking away of dirt and rock as fast as possible from the men. I have said that this feature is often overlooked, and I think it is within the memory of every professional man who has had practical experience in mining that the commonest way in which his foreman "falls down" is from his lack of attention to this "mucking" of dirt. Another point in the sinking of shafts (particularly in the sinking of a vertical shaft) is the relative economy or advantage of sinking (as was done at the Red Jacket shaft on the Calumet) entirely with the tub or bucket, a

cage being installed only when all the sinking was finished. Notable examples of good shaft sinking are found in the Butte copper district, Montana, as well as in the Lake Superior country, one of the most recent being the new shaft on the Mountain Consolidated mine, and also the shaft of the Speculator mine in the same district.

When it is desired to make a production during development of the mine, levels are driven as soon as the shaft has reached a depth of 100 or 150 feet from the surface, and then the sinking is continued. Where shafts are sunk upon the vein (and vertical shafts also) it is good practice to follow the old Cornish method of leaving a "pentice" * at the first level, and to sink below that by means of an auxiliary rope or winding machine. This pentice is afterwards removed as soon as the shaft has reached the depth required for another level. By repeating this process the shaft is sunk continuously, without interfering with the regular hoisting of ore from the mine coming from lateral developments above. In the case (which is rare) of properties that are well-known to be continuous and of large extent, and to contain ore of good marketable grade with a ready sale in the market, it is economy to do all the sinking (or a very large amount of it) before turning off levels. The broken rock then coming from levels, raises, and cross-cuts is handled to the best advantage both as to time and economy.

An equally important matter is the care taken to prevent surface water from reaching the bottom, or in other words, to conserve and stop such surface water at the highest point possible in the mine. In the vast majority of cases the bulk of the water which has to be pumped comes from the surface, that is to say, it comes *above* rather than *below* the depth of 300 or 400 feet. This statement is made with due recognition of the fact that many mines have been dry until large bodies of subterranean water were encountered, but such exceptions emphasize rather than disprove the statement just made. "A manager is known by his dumps," but it is equally true that the capacity of the manager is as often shown by the manner in which he provides for the accumulation and pumping of the water coming into his mine.

Before driving levels to any length, a chamber, plat, or station should be excavated. The location of this chamber or plat in a vertical shaft is not of so much importance, but with an inclined shaft the station must, of course, be made in the hanging-wall of the vein and be carefully timbered or supported, with proper room for switching or

* *Pentice*, derived from the French word "*appentis*"; correlative of the English "pent-house."

dumping cars opposite the winding compartments. A mistake frequently made is in not excavating such a chamber or station of a sufficient height to permit long sticks of timber, long pipes, or other lengthy material to be taken off the cage or skip, as is necessary with wide ore bodies where sills are required to be laid underneath the setts in order to catch and take up properly the subsequent setts in levels below, or (in the system of cross-cribbing largely practiced in Australia) to support the cribs when stoping up from below.

A consideration of paramount importance in the driving of levels upon an ore body is the width of the lode which it is desirable to break. In the case of a wide deposit of ore, or of levels penetrating chambers or enlargements of a vein which otherwise may be comparatively narrow, the amount or tonnage of ore coming from such levels is the chief factor. In most cases a double-track level is entirely unnecessary, provision for rapid tramming and the passing of empties by the fulls being made by "turn-outs." A level 6 feet in width by 7 feet in height, with turn-outs where necessary, is usually sufficient for any metalliferous mine, and in the development of smaller bodies, where the ore body is not as wide as the level, the level should be carried its full width, breaking into foot or hanging-wall, whichever may be the better. Often this is the cheaper, for the reason that the cost of labor and explosives per running foot is *less* than if the miner had to work in a narrow space and confine himself to the natural walls of the vein.

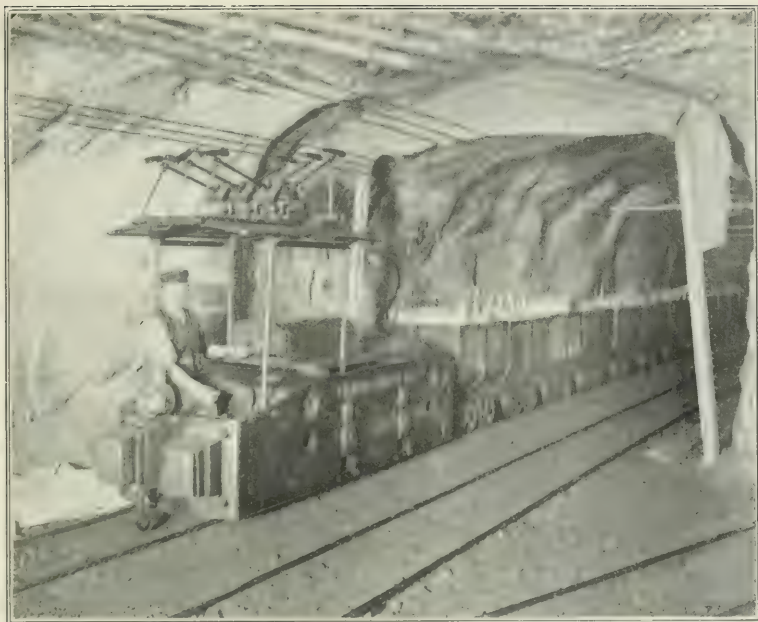
The amount of water coming through a level has an influence as regards ventilation upon the height to which it should be carried. If this amount is large, it is advisable to make a gutter either in the centre or to one side of the level, over which the sills or stringers for the track can be laid; in the case of wet mines such a gutter is a necessity. In long drifts, or where the natural ventilation is bad, a greater height is needed, the air "sollar" being placed in the roof in dry mines. The manager will of course satisfy himself as to the nature of the rock, the character of the walls, the occurrence or non-occurrence of slips, and their dip; whether it is desirable to drive his levels by the "centre cut," "side cut," or some other method. As the object of the levels is two-fold—(1), to open up the ore for quick extraction, and (2), to provide for the transportation of such ore (when mined) as well as waste rock and water, *outwards*, and timber, tools, and supplies *inwards*—the grade of such levels becomes a matter of considerable moment. If the bulk of the tramming is done towards the shaft, and very little away from it, the grade may be permitted to be steeper than if the large percentage of the tramming is inwards from the shaft; the

amount of timber which the stopes require supplies most of the inward traffic. As a general statement, the nearer such levels are driven to a "dead level," or say to a grade not exceeding 4 inches to 100 feet, the better; and when levels are long and unstopped, the ventilation will be better the less the grade is.

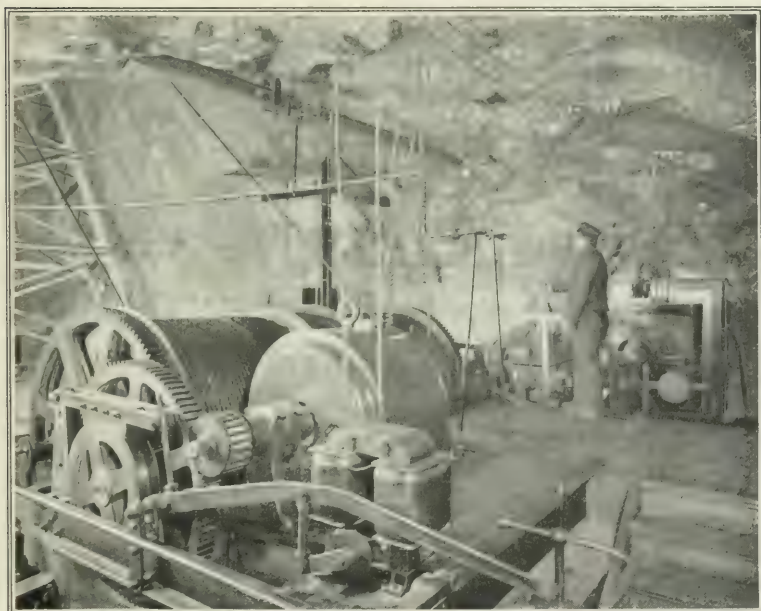
The same remarks that were made in regard to contract work in sinking may be applied to driving levels, and the wise manager will satisfy himself as to right prices in various ways (for example, by driving a new level for, say 30 days, by day's pay and under close inspection from the foreman, with an accurate tabulation of costs). Manifestly a "company account" price should be above the maximum for contract work. Local conditions of labor will determine whether contracts are to be let by the running foot, by the square foot of cross-section, or by the cubic foot of material taken out.

Cross-cutting, or tunnelling, becomes important only when the mine is opened by a vertical shaft and the ore body is found by cross-cuts, or when the main opening to the deposit is by a large cross-cut tunnel, or where there occur veins, parallel to the main vein, which are profitable to work. The essential distinction, so far as the management is concerned, between a tunnel and a level is that such tunnels usually demand a width sufficient for a double track, and a sufficient height to permit of mechanical haulage, either by mules, horses, or electric power. Under such conditions the average dimensions of such tunnels are about 7 feet high by 8 wide. In the long adits in use at the Hall mines in British Columbia (where haulage is by mules) the timbering is 8 feet wide on the sill level, and 6 feet wide on the cap level "in the clear," and the vertical height is 7 feet. In Colorado, at the Stanley mine, it has been found in the "road adit" that a single track, with turnout sidings, is preferable to a double track; all determining conditions are local with each individual property. The same considerations apply to cross-cuts from a vertical shaft to cut a vein, also to cross-cuts driven from one vein to a parallel one, when they are made for working purposes, and not simply for prospecting. The matter of drainage in main cross-cuts is important in many cases.

The primary object of raises is to open up faces for stoping the deposit, as well as for prospecting and for ventilation. The raise is really a part and parcel of the stope, and its dimensions must be governed by the width of the ore body, or the amount of ore which it is designed to pass. As they should be permanent, being most valuable factors in ventilation, and also useful as gangways, they should be driven upwards along the foot-wall (or *in* the foot-wall) of the de-

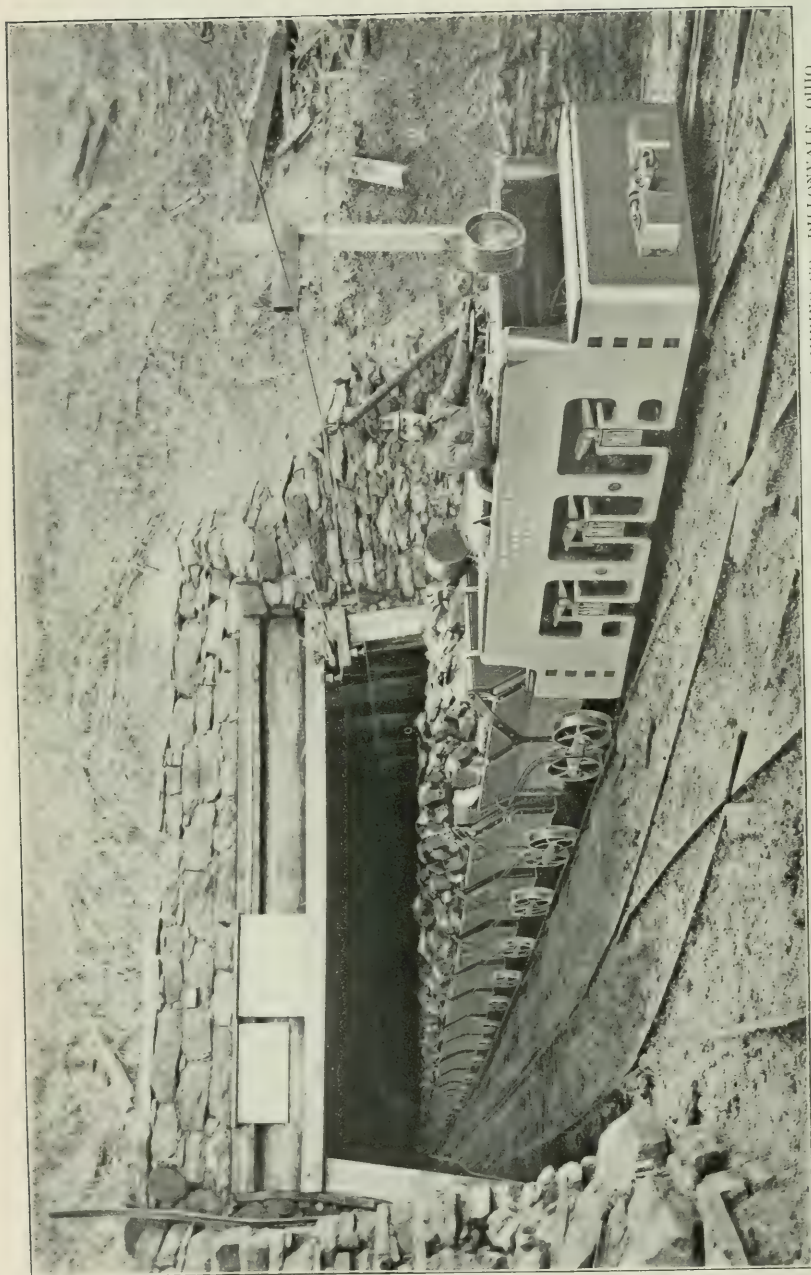


Three-trolley electric locomotive with train of loaded cars coming out of a German mine. Siemens & Halske system.



Electric winding engine used in the mines of the Consolidated Alkali Works, Germany.

APPLICATIONS OF ELECTRIC POWER TO MINE HAULAGE.



ELECTRIC MINE LOCOMOTIVE WITH TRAIN OF LOADED CARS, WHEELING & LAKE ERIE COAL MINING CO., DILLONVALE, OHIO.

The locomotive weighs 30,000 lbs., has a draw-bar pull of 5,500 lbs. on the level or 4,300 lbs. on a 4 per cent. grade, is equipped with three 35 horse-power, 220-volt direct-current motors, and maintains a speed of 6-10 miles an hour; its gross load at a speed of 8 miles on level track is 183 tons, on a 2 per cent. grade 70 tons, and on a 4 per cent. grade 39 tons; these rated capacities are exceeded by about 15 per cent. in actual work. The locomotive hauls cars from a parting about $1\frac{1}{2}$ miles from the mine mouth; smaller (6-ton) electric locomotives bring the trips to a gathering switch, from which this 15-ton locomotive does the main hauling. Jeffrey Mfg. Co.

posit, and should be wide enough to permit of partitioning off a compartment for a ladder-way. The reprehensible practice of miners throwing tools down the raise or winze (usually down ladder-ways) will be known to the manager, who will provide against it by furnishing "nippers" or tool-boys, and by holding the miners responsible for all tools lost or thrown into the ore pass.

The distance between upraises depends on the main points of how quickly it is desired to stope out the mineral, the distance to which muckers can throw waste rock, and also upon the amount of waste which has to be stoped and held on timbers. Where there are large amounts of waste and small amounts of ore, the raises may be farther apart, as also when the whole mass stoped is ore which subsequently has to be sent to the surface. In the later case the stopes themselves constitute an ore bin, the broken ore lying upon the stulls until it is needed on the surface, when its place may be taken in the empty stope by rock-filling subsequently sent down.

The methods governing the extraction of ore from a deposit depend upon the deposit's width, whether the whole width or only a part of it contains valuable ore, the nature and character of the walls, and the inclination of the deposit. For wide ore bodies, where the whole or the greater part of the material broken is valuable and where there is comparatively little waste, the underhand stope has advantages; but where a large proportion of the rock broken is waste (*i. e.*, not ore) or when the vein is narrow, with good walls, overhand stoping is to be preferred. Among the advantages afforded by overhand stopes are: that a unit of explosive breaks more ground, gravity assisting it; there is also less handling of broken material, the waste being allowed to lie where it falls; there is better ventilation, and less timber is required than in an underhand stope. The disadvantages are the costs of the raise and the losses of ore which occur in the waste. The underhand stope requires no raise, incurs no loss of ore broken, and is better for veins with flat dips where the ore will not "run" on the wall; but against it are the disadvantages that all the ore broken has to be raised, that lean bodies occurring in the stope can not be left as pillars, that larger amounts of timber are required, that the ventilation is poorer, and lastly that water accumulates. For a narrow lode, where the filling is chiefly of sufficient grade and value to send to the surface, the underhand stope is preferable, but where a large amount of rock has to be broken to get a comparatively small amount of ore the labor of handling such waste prohibits any but an overhand stope.

The timbering of the stopes depends upon the width of the ore

body to be removed and the character and quality of the walls enclosing it; the cost of timber as compared with cost of rock filling; and the necessity of keeping gangways open for ventilation, and for possible egress in case of accidents. Where the body is large and the walls are poor, the manager will keep constantly in sight the feasibility of using rock filling, which has been employed to such advantage during the last twenty years all over the world. This rock filling, which is an absolute necessity for some deposits, can be gotten either from the development work proceeding in the mine, *i. e.*, from levels driven in the country rock or from cross-cuts, or it can be sent down from the surface, being quarried from some spot conveniently near the mouth of the shaft. There is no one subject perhaps on which the manager will show his ability, or inability, to fill his post so quickly as in this matter of supervising stopes. He will find his costs varying greatly, according as this matter is properly or improperly dealt with, and he will use up much of the gray matter of his brain in solving the problem.

To get the best results from subordinates and workmen, the manager needs to use a mixture of both intimacy and reserve, which to be successful, depends either upon his "personal equation" or his worldly experience, and perhaps on both. With the subordinates of his staff he must keep constantly in touch; a daily round, with personal conversation, gives the required intimacy. In his conversation, and by questions, he can impress upon each one the necessity for exact information upon the smallest details, which, skillfully done, produces the second desirable effect of reserve, provided he is, and shows he is, a master of the branch he is dealing with. He can also thus impress upon the subordinate the necessity for rigid economy. By his own methods he can give the object lesson desired of rigid economy, full knowledge of detail and loyalty to the company, and, in mining as in other businesses, example is better than precept. If he be careless, he will find the contagion spreading as quickly as a zymotic disease, and proving as virulent.

Each subordinate should be chosen for his knowledge of his particular department, and led to expect from each man under him a fair return for his wages. He must know what every expenditure (either for labor or supplies) *ought* to produce, and if it is not produced, then he must give the very best reasons *why* it is not. By inculcating the precept that, around a mine at least, everything that costs money must produce money; by having no "favorites" of his own and insisting on others having none; by ruthlessly requiring the dismissal of drones, and announcing that all "soft jobs" are reserved especially for him-

self, he will quickly get his staff into the habit of expecting the best results from the money expended; and, as such methods are catching, it will not be long before his staff will require from the workmen under them the same rigid and economical, but square, methods of doing work.



MECHANICAL TRANSPORT FOR ECONOMICAL HANDLING OF THE OUTPUT OF THE COAL MINE.

Installation at the Boston Breaker of the Delaware & Hudson Co., Plymouth, Pa., U. S. A. A 272-foot steel truss supports a monobar conveyor, carrying coal at the rate of 4 tons per minute from cars to top of breaker. Link Belt Engineering Co.

Of the various methods of inducing labor to extra effort, such as the "premium" system, the "bonus," or the profit-sharing idea, there is not room in this article to treat. It is a matter of record that in some mines these schemes have worked successfully; it is equally on record that in others they have not.

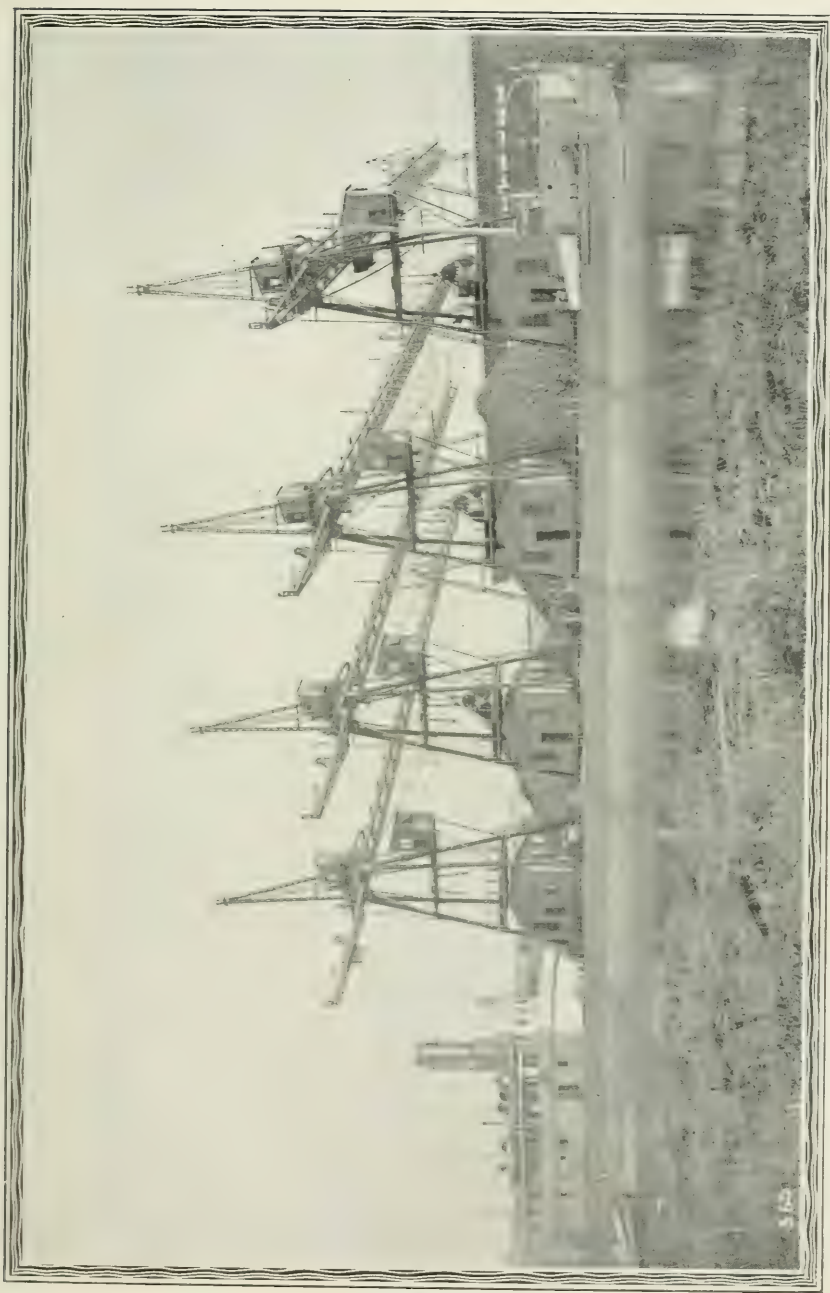
The manager will be aware of the many advantages of working "mixed crews," of mingling nationalities as a sort of insurance against labor combinations and strikes, and he will find that a knowledge of men is as important a qualification for a good manager as a knowledge of technicalities; for while one can "hire" specialists in any branch of science he can not hire specialists in the knowledge of human nature.

In his supervision of surface operations the manager is governed by the same ideas which influence his administration of underground work, but he should never lose sight of the fact that all labor, to him, is divided into two classes: one, and the smaller usually, which *produces* material from which money is obtained, the other (though useful and absolutely necessary to handle this material) is one which adds no increment to the value contained, but *consumes* a portion of that value in the payment of its wages. Into the latter class come all surface men, and hence the necessity for closest supervision and scrutiny of all surface work. The various ways in which economies may be effected in the boiler-house, in the consumption of fuel, the hand-



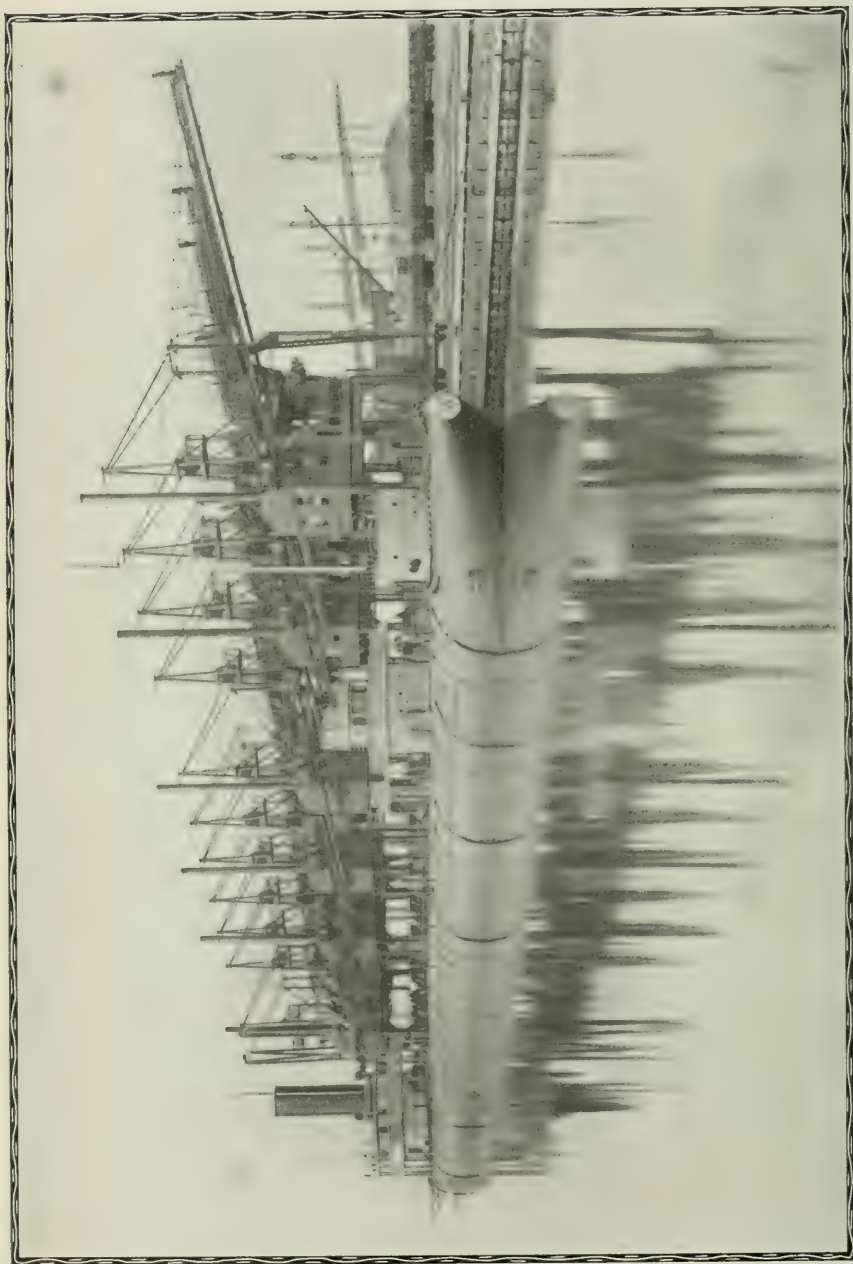
ECONOMY IN HANDLING THE PRODUCT OF THE MINE.

Retarding cable conveyor for handling coal, Dayton Coal and Iron Company's mines, Dayton, Tenn.; operated by 15-horse-power electric motor, and fed by three men; 500 feet between centers, travel 100 feet per minute; delivers 125-150 tons run-of-mine coal per hour, without breaking, to a picking table. The tram, which it replaced, had but 1-3 of the capacity, did not give continuous feed to the picking table, and involved much larger wear and tear and running expense.



AN ADVANCED EXAMPLE OF ECONOMY IN AMERICAN COAL-HANDLING PRACTICE. MECHANICAL HANDLING FROM MINE-LOADED CARS TO WHARF-BACK LAKE CARRIER.

The plant is that of Cox & Bros., Milwaukee, who ship direct from their own mines to their own colliers. The four bridges shown have each three drum engines, operating 60 cubic-foot grab buckets. A 5-ton weighing scale on each bridge is operated from the scale house shown on top of bridge, above operator's house. Brown Hoisting Machinery Co.



A FACTOR IN THE MARVELLOUS ECONOMY OF MINING THE MINNESOTA IRON ORES. UNLOADING ORE FROM LAKE CARRIERS AT A TERMINAL, PENNSYLVANIA COMPANY'S DOCKS, ERIE, PA., U. S. A.

The bridge tramways have cantilever extensions 80 feet long, extending over four tracks. They usually unload from steamers direct to cars, but have room to store one or two large cargoes on the wharf if no cars are at hand. Loading may be from either wharf or ship into cars. The plant is steam-operated, one engine house serving a pair of machines.

The capacity is 1 ton per trip. Brown Hoisting Machinery Co.

ling of the same and disposal of ashes, the care of grates, etc.; and in the engine-room, where oils and supplies of various kinds may be wasted, or filtered and washed for re-use, are matters demanding the attention of the men employed and the close scrutiny of the manager.

One of the important points in surface work is the prevention of the too-common wasting of ore in the dumps. An old and ever-true proverb is "A manager is known by his dumps," and examples will occur to the reader of the mine dumps he has seen which contained ore, and of the many he knows of that have been sorted and re-sorted at a profit. Daily inspection of the record kept from the "tally" boards, both below and on the surface, and a visit to the end of the dump each day, will set the manager thinking, and will produce an increased tonnage if he is worthy to "hold down his job." A still greater source of waste, perhaps, is found where it is concealed from public observation, viz., in the stopes of a mine. There are many cases where such filled stopes have been profitable ore bodies; where subsequent management has pulled the scaffolds, picked and hoisted the ore, with profit as a result. In precious-metal mines this is perhaps one of the most frequent exhibits of incompetent management. Difficult as it is to sort ore on the surface in broad day-light, it is far more difficult to sort it by the light of candles in dark stopes, yet from the standpoint of small costs and high results, it is often one of the points best worthy of the manager's attention.

A manager has also to satisfy the labor he employs as to comfort and health, if the mine is (as is usually the case), in the wilderness, or apart from villages of considerable size. It does not pay a company nor a manager to have his men discontented or sick, nor to have his force constantly changing because of dissatisfaction. He must therefore give due heed to the "bunk house," and "boarding house." In many places accommodations for the two classes of men, married and unmarried, are needed. Where the latter are employed provisions have to be made for their wives and children, and separate cottages or small dwellings become a necessity. For single men the bunk-houses should be separated into several large rooms, so that "chums" may get together, and that the personal convenience of the different groups of men may be considered. Order and cleanliness must be enforced, and provision made that each sleeper in a room has at least 300 cubic feet of space. For small forces the manager, or one of his staff, with the help of a small medicine chest, can act in cases of illness; for a large force of men, however, it is better to have a resident physician, and charge each man employed a certain amount per month as "doctor's

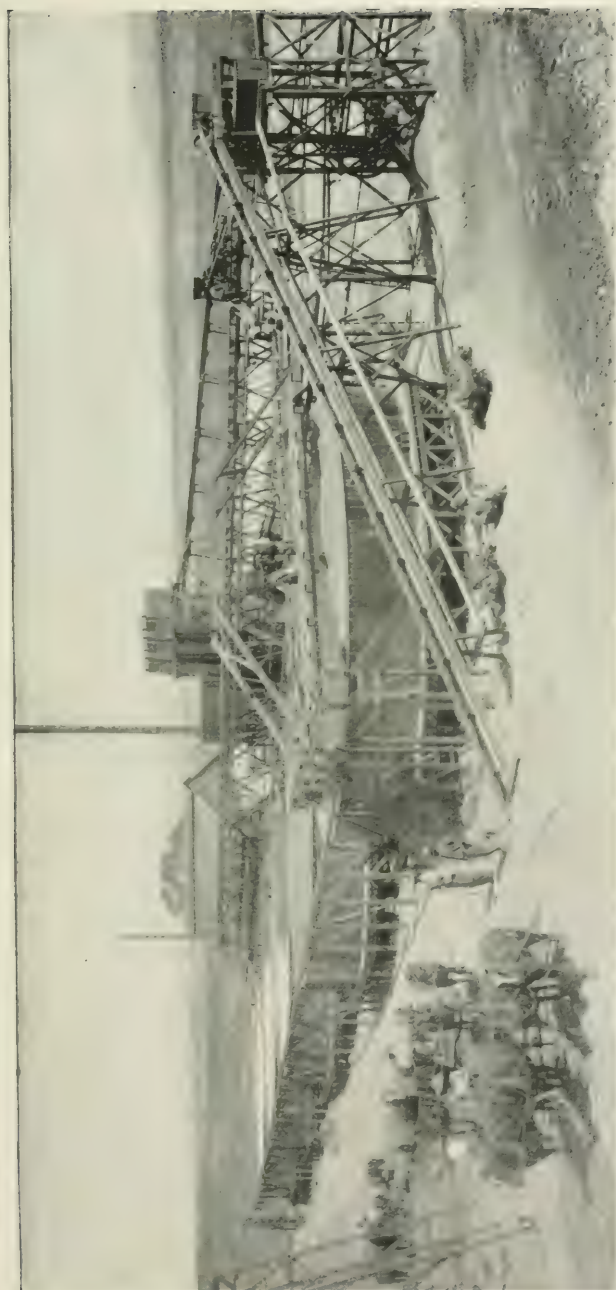


HIGH ECONOMY IN PLACER MINING THROUGH THE ADAPTATION OF MECHANICAL TRANSPORT.

The upper picture shows the radial travelling cableway—the latest development of this form of apparatus—at the German Bar Mines, Adler Gulch, Montana. The traveling tower, shown in the right foreground, has a speed of 300 ft. per minute. The entire operation of the tower, of digging, hoisting, conveying, and delivering, is performed by one operator and one fireman. The entire area which can be swept is under control of one man. The capacity is 1,000 tons a day. The

lower cut shows the hopper, grizzly, and gold-saving sluice.

Lidgerwood Mfg. Co.



SUCCESSFUL REWORKING OF TAINTOS PILE BY THE USE OF IMPROVED PROCESSES AND ECONOMIC MECHANICAL TRANSPORT

The illustration is taken from the Mammoth plant, Mammoth, Arizona. Two belt conveyors, a "trunk line," and a "distributing line" are used. The trunk line is carried on a high trestle running parallel with the line of waste tanks. The distributing line, running at right angles to it, is supported on a trestle bridge spanning the tanks and moving over them as would a travelling crane. The trunk line is provided with a movable tripper which follows the movements of the distributing conveyor and delivers the ore to it. The tripper operating on this distributing line is of the self-driven, self-reversing type and travels back and forth, unloading the belt evenly and continuously. By this system, the ore is carried to any tank and evenly distributed therein, with only one man to superintend the operation of the machinery. The even distribution of the material permits of a more thorough treatment of it than is the case when it is dumped from cars in the center of the tank. At the Mammoth plant, the ore is brought from an old tailings pile by horses and dumped into a hopper flush with the ground which feeds to an inclined conveyor, elevating the ore to the trunk line conveyor. The installation was made by the Robins Conveying Belt Company.

fees." In the case of smelting works, or of lead mines carrying much carbonate of lead (cerrussite), a small hospital may become necessary. Where the company provides sleeping and eating accommodations for the men it is found best to put this department into the hands of a responsible man, separate from the mine, but subject of course to the manager, who makes such conditions or rules as are for the best interests of the men. This should never be "let out" to a contractor unless under provisions and conditions so stringent as to enable the manager to demand at once rectification of wrongs, and equally demand preservation of order and morality.

Another important point in the management of wet and dirty mines is the providing of a "changing house." Men come off work wet, perhaps with working in wet places, perhaps with perspiration from working in hot places in the mine, and provision should be made for this by establishing a house or room heated by exhaust steam, hot water, or by fires. Such a room or building is best made with a cement floor, as a wooden floor is sure to shrink under the heat, and when full of cracks it can not be thoroughly cleaned. The walls should be frequently whitewashed to sweeten the atmosphere. In wet mines, particularly in shaft sinking, the company has to provide the miners with clothing and boots.

In some countries the manager must be his own magistrate, but in all countries he should thoroughly familiarize himself with the provisions of the mining law of that country and of any special legislation affecting the mineral industry. He should also be versed in the laws governing the hiring of labor and the making of contracts, and of the procedure required to obtain the control of such water-courses or forests as may be necessary for the successful operation of his plant.

In order to produce the best results from capital expended, the manager must be autocratic. Not the least of his duties is to impress on his board the importance of the "one man" power and responsibility. There must be no chance for interference in his organization, no opportunity to appeal from him to his board, by either men or manufacturers, otherwise the regular, and not intermittent, character of the work can not proceed smoothly. With this power must go equivalent responsibility, and then will the company be safeguarded against interruptions by the breaking down of cheap machinery, or by the interference or incompetency of cheap men. No director nor combination of directors, can (or should attempt to) control the manager on these important points. Unity of decision, of authority, and of responsibility are essential for successful mine management.

PRINCIPLES AND METHODS OF PROFITABLY WORKING THE MINE.

OFFICE ORGANISATION, COST-KEEPING, AND RECORDS OF WORK DONE.

By A. G. Charleton.



HALF the art of mine management consists in organisation of one sort or another, so as to secure careful book-keeping, time-keeping, and store-keeping; in the proper checking of measurements, values, and weights, so as to insure their accuracy; and in substituting surveys and working-drawings for guess work and "happy-go-lucky" methods; the necessity for this increases as the undertaking grows in size. It is, however, a fatal mistake to organise the business of a small undertaking at the start on the same lines as those of a large concern, and judgment has to be exercised in avoiding carrying organisation too far, by burdening it with "dead-weight charges" which it cannot stand; just in the same way that a mine may easily be ruined by the premature erection of plant before it is sufficiently developed to justify such an outlay.

I have myself run a fairly large mine, with no assistance beyond that of the mine shaft-bosses and mill-men, with a good machinist to look after the plant; whilst in other cases, a large staff and elaborate organisation, such as I have before described, may not only pay but prove an absolute necessity to secure profit. This is, I think, generally

Probably no branch of engineering enterprise has undergone a more rapid and radical change than has mining. Not only have power applications made the scale of operations in individual mines so vast that only by the most efficient organisation can co-ordination and direction of the whole enterprise to definite and harmonious ends be secured. Not only has a system of management become necessary to carry the individuality of the manager throughout his work. More than this—the position of mining has changed from that of a gaming venture to that of solid industrial enterprise, founded as securely and carried on as economically as the business of a specialised machine works.

It is to the commercial mind working in sympathy with the technical ability that much of this reduction to an exact science is due. The methods of registry and record which furnish the engineer with his data are pre-requisite to material success. Systems must be varied to suit special cases, for mining is supremely subject to local conditions; the principles are fixed. To these and to examples of their application Mr. Charleton directs attention in this article.—THE EDITORS.

speaking, more particularly the case where large quantities of a comparatively low-grade ore have to be dealt with, where a few cents per ton one way or the other in the working costs per ton of ore handled make the difference between a large profit and a large loss. Not that I mean to infer that a rich mine is any justification for want of organisation—quite the contrary; but the factor that chiefly decides the question is the magnitude of the operations involved. Hence it is that special attention has to be directed to the subject in mining operations carried on upon a large scale, like those of the Rand, the Alaska-Treadwell, the Homestake, and the copper mines of Butte (Montana) and Lake Superior.

When admissible, such labour-saving devices as the typewriter, shorthand-writer, telephone, and calculating machine will save money in the office, and it is of the utmost importance to systematise the work by the employment of suitable "forms" to be issued to, and filled in by, the different heads of departments; coupled with a method of filing all papers and documents by which any particular form, machinery catalogue, report, or document can be turned up at a moment's notice.

Few mine managers, however, seem to understand thoroughly the function of cost-sheets. They are not, in fact, designed so much to show what has been spent in any particular period (for that is shown by the ordinary mine accounts) as intended to enable the manager on the spot to determine his exact expenditure, from month to month, on *every branch and piece of work in progress, separately*, so that he can tell if a stope is paying or is unprofitable, if a level is costing more than it ought to cost to drive, and when a man can be put on or knocked off the pay-roll with advantage; in fact, speaking generally, whether labour and materials are being economised or not. He is then able to put his finger on the right spots, and cut an assured loss or add to profits when it is possible to do so, which is the only certain way to secure real economy. It is to be regretted, moreover, that even in cases where a system of this sort is properly carried out, there are such wide differences in details in the method of subdividing costs that it becomes difficult, if not impossible, to compare the expenses under any particular head in one district, or even in mines in the same district, one with another. It would be a step in the right direction, I think, if the mine managers' associations and chambers of mines in important centres were to discuss the subject and endeavour to arrive at some joint understanding. Excepting in some degree the Rand, I consider the general want of uniformity in the information available at most mines, in matters relating to cost, to be regrettable, because

commercially speaking—so far, at any rate, as regards gold mines—uniformity could do no possible harm to the proprietors and would be of the greatest possible advantage to mining-men generally, by permitting practice at one mine to be compared with that at another; this would enable mine managers to ascertain in what directions costs can best be reduced, where additional saving is possible, and where additional expense is inevitable.

In a paper read before the Institute of Mining and Metallurgy, I have already described in detail the method I have usually adopted myself, which may doubtless be improved upon, expanded, or simplified to suit special circumstances.* By this method, in addition to the ordinary accounts sent to the head-office (accompanied, as is usual, by duplicates of the pay-sheets and vouchers and a fortnightly report in the form of a letter, describing the developments underground and dealing with matters of business generally), the manager should forward home monthly the following cost-sheet forms and returns (which can be found in the paper to which I have referred), keeping, of course, a copy of them at the mine. This is done for the guidance of the company's consulting engineers, as I assume, of course, that a company employs some responsible firm to advise them on professional matters of this kind. Technical experience is necessary to make use of information of this kind and to understand its bearing.

- (1)—The Working Expenditure and Revenue Form, showing at a glance the actual expenditure incurred and revenue received during the month, in detail; giving as well a *résumé* of working results, such as: Total number of feet sunk in shafts and winzes, risen and driven, in levels and cross-cuts; total cubic feet or square fathoms stoped; number of tons of ore delivered at surface and crushed; ounces of amalgam and bullion produced; yield in melted bullion per ton; total cost per ton crushed; value of bullion per ounce; assay of ore delivered at the mill and discharged from the battery; tailings assay; assay of concentrates, and quantity of concentrates produced.
- (2)—The Mine-Working Statements (divided for convenience into two separate sheets, called A and B), which give the following particulars under tabulated headings of each of the different shafts, levels, winzes, cross-cuts, stopes, etc., in progress, viz:

* NOTE.—This paper can be obtained as originally published, or forms of full size, with an explanatory pamphlet, can be got from the publishers, Howard & Jones, 15 and 16 Cullum street, London.

The distance sunk or driven; total length of drivages; cubic feet or fathoms stoped; width of formation; width of pay ore; average assay value; pan-assay of free-gold; percentage of sulphurets; changes remarked in the lode or country; strike, dip, and throw of faults or cross-courses encountered; tons of ore produced; total one produced to date; number of shifts worked by miners, truckers, and timbermen; the separate gross cost of labour and supplies; the separate cost of labour and supplies per foot of advance (in levels, etc.), and the separate cost of labour and supplies per ton of ore mined (in stopes), in the various working places.

(3)—The Stores-Account Forms, which show:

(a)—The quantity and value of stores used each month, charged to the various Mine, Mill, and other accounts, into which Expenditure is split up, in the form first mentioned.

(b)—The quantity and value that each item of stores in general use represents, per ton of ore raised, mined, or milled, as the case may be, during the month.

(c)—Stores on hand at the beginning of the month.

(d)—Stores purchased during the month, and

(e)—Total stores on hand at the end of the month.

These three principal series of forms it may sometimes be necessary to supplement by others, such as:

An Assay Form showing:

(a)—Widths and values of ore developed, and the calculation of the average widths and values entered on the assay-plan during the month.

(b)—General assays of special mine-samples, mill-samples, etc.

A Mill-Working Statement, when, as is sometimes the case, ore is treated for outside parties; that is to say, if "customs work," as it is called, is made a feature of the business.

A Memorandum, giving particulars of bullion, when, as is usually the case, it is melted and refined at the mine.

In using these various forms there is plenty of scope for the exercise of a certain amount of private judgment, so as to adapt details to circumstances without altering the general principles upon which they are framed, upon which I may add a few words.

As regards the Working Expenditure and Revenue: The question to be first settled is to determine the main headings under which it is advisable to classify expenditure, so as to keep expenses of different kinds distinct from one another; under ordinary circumstances it will,

I think, generally be found sufficient to divide them under Mine Account, Mill Account, General and Surface Expenses, and Capital Account. These main headings, to render cost-sheets of any practical value, should, however, in my opinion, be subdivided under various principal sub-headings; as, for instance, I always like to divide Mine Account into:

- (a)—General Charges: (Including as separate items supervision, hoisting and landing, compressed air, timber and timbering, track-laying, underground tramming, and pit-work.)
- (b)—Mining.
- (c)—Development, as shown in the accompanying specimen (Table I., page 691).
- (d)—Prospecting (diamond-drilling, etc.) may also occasionally demand a separate sub-division.

Sometimes, however, a certain proportion of the above-mentioned General Charges are charged to Mining, and the remainder to Development: whilst in other cases, Development is charged, in whole or in part, to Capital Account: and most frequently of all, General Charges, Mining, and Development are all hopelessly mixed up together under the heading of Mining, without any governing principle at all.

Then again, under the head of Mill Account, it is equally necessary to keep battery-expenses, tailings-treatment (cyanide), and ore-shipment expenses separate, where such charges form part of the working expenses; General and Surface Expenses often include office expenses (itemised), as well as tramming, crushing, and sorting, under separate heads: and in the case of Capital Account, where works are under construction, the cost of the erection of any particular building or piece of machinery should be shown separately and charged to its proper department.

The next question to be settled is the classification of items of expense, under each sub-heading of expenditure.

In this connection I consider that in the case of Development (sinking and driving) and Mining (stopping or "getting ore"), it is sufficient to classify expenses under two divisions:

(A)—Labour.

(B)—Supplies and Stores.

These two elements should appear in *all* the other subdivisions of the cost-sheets, but with various additions.

Thus, under Mine Account, General Charges, and under Mill Account, supervision, fuel, water, tools, and repairs-to-plant, should be shown apart from one another, and under General and Surface Ex-

penses such items as sorting, surface transport of ore, general charges (including rent, taxes, insurance, etc.), and office expenses, ought to be classified separately.

The two great items of expense which enter into every branch of work being, as already said, labour and supplies, particular attention should be directed:

- (1)—To accurate time-keeping.
- (2)—To showing in the pay-sheets or labour-books how labour has been distributed during the month, *under all the various sub-headings which appear in the cost-sheets, i. e., on the Working Expenditure and Revenue form.*
- (3)—To show in the same way in the Stores-Account forms what stores have been charged under each sub-heading given on the Working Expenditure and Revenue form.

Accurate time-keeping depends largely on the care taken by the time-keeper, or the various foremen in charge of departments, in noting carefully the time spent on different jobs, although men like blacksmiths, carpenters, and others may in some cases be trusted to keep a record of the sub-division of their time upon work under construction. With this object, it is not unfrequently the case that a board (painted black, and specially ruled for the purpose) is hung up in the shops or mill, for particulars that may be required, which are chalked upon it from day to day by the man in charge, and entered by the foreman in his time-book, or on a sheet such as the labour-docket which I advise using.

In any case, the foreman should carefully check the men's time himself for entry in his time-book, and the pay-sheets or labour-books should be so ruled and entered up as to show what jobs each man has been engaged upon; that is to say, the pay-roll, unless due-bills, which are sometimes used (as described by Mr. Hardman), are employed instead, should not only state his occupation, whether miner, trucker, lander, timber-man, carpenter, or blacksmith, but also—supposing, for example, he is a miner—on what face, stope, or job, each man has been engaged, and what time he has put in there. The various working-places and pieces of work may often be distinguished, for the sake of convenience, by distinctive numbers.

Mr. W. B. Middleton, in a paper on "The Segregation of Mine Accounts," read before the Institute of Mining and Metallurgy, February, 1900, describes a modification of the above method, by which each workman is provided with a labour-check, which he fills in himself, and hands in daily at the office; but whatever system is used the

1898.	Gross.		Total.		Per ton.		Total.		Gross.		Total.		Per ton.		Total.	
	£	s. d.	£	s. d.	£	s. d.	£	s. d.	£	s. d.	£	s. d.	£	s. d.	£	s. d.
MINE ACCOUNT—																
General Charges.																
Superintendence and Labour.....	491	1 3			23	7-46			473	5 4			12	0 87		
Fuel.....	99	18 3			2	9-26			128	10 5			3	3-44		
* Supplies and Stores.....	65	19 2			1	9-06			33	1 1			0	10-12		
Tools.....	5	3 0			0	1-71							0	4-50		
Repairs.....			66	2 1			0 18 4-39		14	17 10			0 16 6-99			
Mining.																
Labour.....	270	4 0			7	7-04			284	13 4			7	3-14		
* Supplies and Stores.....	24	3 9			0	8-05			27	7 3			0	8-37		
Development.																
Labour.....	345	13 4			9	7-15			401	17 0			10	3-02		
* Supplies and Stores.....	37	8 2			1	9-45			37	8 2			0	11-45		
Total per ton mined.....			1345	15 11			1 17 3-98		152	6 8			3	11-11		
MILL ACCOUNT—																
Labour.....	142	7 1			4	1-59			64	8 0			2	1-82		
Fuel.....	74	3 0			2	1-82			81	10 0			2	1-00		
Water.....	74	0 0			2	1-79			21	18 10			0	6-79		
* Supplies and Stores.....	26	13 2			0	9-38			0	3 9			0	0-06		
Tools.....									5	10 6			0	1-85		
Repairs.....	14	5 0			0	4-06							0	8 4-93		
Total per ton milled.....			331	8 3			0 9 7-44		174	19 10			4	6-12		
GENERAL AND SURFACE EXPENDITURE ACCOUNT—																
* Supplies and Stores.....	173	0 0			5	0-42			15	17 6			0	4-91		
Transport of Ore.....	4	13 4			0	1-02			5	12 9			0	1-73		
Tools.....	2	12 0			0	0-90			0	13 6			0	0-29		
Repairs.....									7	8 6			0	2-30		
Fuel.....	7	8 6			0	2-60			57	15 2			1	5-87		
Office Expenses.....	50	11 6			1	5-61										
Management.....																
Assaying.....																
Total Mine & Mill Working Costs.....			238	14 4			0 6 11-15		169	16 5			4	8-53		
Average cost per ton of Ore milled.....			1015	18 6			2 15 7 37		31	17 4			0	2-96		
CAPITAL ACCOUNT—																
Labour.....	149	17 1							256	10 1						
* Supplies and Stores.....	70	16 4							105	7 9						
Tools.....									3	8 9						
Freight.....									30	17 4						
Fuel.....																
Supervision.....																
Contracts for erection of plant.....																
Tons mined.....			221	5 11												
Tons milled.....			721	689												

* As shown by the "Stores returns." Deducting supplies purchased from the company by contractors.

TABLE I.—FORM FOR GENERAL MONTHLY ANALYSIS OF MINE COSTS.

result should be the same, viz., to enable the number of shifts, or hours spent on each job, to be subsequently entered in a "Detail Labour book"* and "Cost Minute Book"; or on a "Labour-Distribution Sheet," as described by Mr. Middleton, showing what all work has cost so far as concerns labour, and how far each man has contributed a proper and reasonable proportion of time for the wage he receives.

In carrying out the system I use, these particulars should be entered in a special "Labour Ledger," and such of them as relate to driving different levels, stoping, etc., should be shown on the Mine-Working Statement A, besides entering the total cost of labour, under each separate sub-division, on the Working Expenditure form.

To ascertain the exact cost of work, however, accurate store-keeping is no less requisite than accurate time-keeping, and for this purpose it is essential that all requisitions for stores should be made on a Stores Docket, showing to whom stores have been supplied and for what purpose. Full particulars on the latter point should be entered in the Stores-Delivery Books, and details of all such transactions ought to be subsequently entered up in the Stores Ledgers, under various accounts, which should correspond with those running in the Labour Ledgers. Those stores-charges relating to the mine (driving different levels, stoping, etc.), of course, are to be shown on the Mine-Working Statement in the same way as those relating to labour.

Whatever system is employed, a Stores Book, giving particulars of stores received, must be kept, as well as a Mine-Stores Delivery Book, which may be used in conjunction with separate Mill and General-Stores Delivery Book, for convenience's sake, in place of only one Stores-Delivery Book.

In the same way, the Stores-Account forms sent to the home office may either be divided under separate headings, such as Mining General-Charges Account, Mine Account, Development Account, Mill Account, General Surface Account, and Capital Account, to correspond with the subdivision of the Working Expenditure form, or one form may be used, ruled the same way as that form, but with a number of extra columns, showing the total amount and value of each item of stores consumed, and its cost per ton, chargeable to Mine General-

* The fine point to which this requires to be carried in shop-practice, in order that the employer may realise full value for the time for which he pays, has been well shown in many papers on Cost Keeping in this Magazine and in an article in the *Iron and Coal Trades Review* of Nov. 10, 1899, entitled "An Automatic Cost Distributing and Accounting Plan"; a time-recorder, registering on a strip or card-system, being employed in this latter case to check the men's time.

Charges Account, Mine Account, Development Account, Mill Account, etc., for which the extra columns in question are set apart.

Assuming that an equally careful record has been kept of such items of expense as fuel, mine timber, lumber, and water—which do not strictly come under the head of stores, but which should be entered in the Stores Book, Stores-Delivery Books, and Stores Ledgers—and of various general expenses, such as office expenses, freight, insurance, and taxes, etc., which are charged in the mine head-office ledger, a manager is now in a position to ascertain not only what his expenses have been, but the various directions in which they have risen or fallen. He can consequently enquire into the causes that have contributed to a rise or fall in cost, with a view to profit by this knowledge in the future, providing only he possesses the necessary experience and technical knowledge; otherwise, it is more or less labour thrown away, for which the company pays without deriving any substantial material benefit.

The pay-rolls and stores-accounts, although they provide the material, are not of themselves in a suitable form for the purpose aimed at, as what is wanted is to see at a glance each month where expenses have risen or fallen, and immediately to locate the cause of the one, as much as of the other. To effect this, the first step that should be taken is to enter the figures given from month to month in the Working Expenditure form in the manner shown in Table III., headed "General Analysis of Mill Account Costs," a similar analysis being made of each of the other subdivisions of Table I., which affords an example of the monthly entries as they appear in the Working Expenditure form. The next step is to make a detailed analysis of the labour (as shown by the pay-sheet) under each subdivision of Table I., of which an illustration is afforded by Table IV., which shows how mill-account labour is treated. The third step is to dissect supplies, in precisely the same manner, from the particulars given in the Stores-Account forms, and similarly to deal with the quantities of timber, fuel, water, etc., charged to each sub-account.

With these data, there is no difficulty in presenting a summary of working costs, half-yearly or annually, as shown in Table II., which, in the instance shown, is amplified by special analysis of the Mine General Charges, the Mining Account, Development Costs, and Mill Account, designed further to itemise and distribute the totals given; or, with the aid of the labour and stores-ledgers, to keep a cost minute-book on the system described by Mr. Hardman (as exemplified in

TWELVE MONTHS.	GROSS.			PER TON.		TOTAL PER TON.	
	£	s.	d.	s.	d.	s.	d.
MINE GENERAL CHARGES—							
Superintendence and Labour	4811	1	5	9	1.383		
Fuel.....	1266	17	10	2	4.803		
Supplies and Stores.....	505	13	10	0	11.497		
Tools.....	39	11	1	0	0.899		
Repairs.....	97	7	7	0	2.214	12	8.796
	6720	11	9				
MINING—							
Labour.....	3363	16	9	6	4.479		
Supplies and Stores.....	344	15	0	0	7.838	7	0.317
	3708	11	9				
DEVELOPMENT—							
Labour.....	4770	19	3	9	0.472		
Supplies and Stores.....	656	14	7	1	2.933	10	3.405
	5427	13	10				
MILL—							
Labour.....	1882	8	3	3	8.510		
Fuel.....	937	18	4	1	10.179		
Water.....	1005	11	6	1	11.777		
Supplies and Stores.....	335	8	9	0	7.931		
Tools.....	6	10	1	0	0.153		
Repairs.....	151	0	1	0	3.570	8	6.120
	4318	17	0				
GENERAL AND SURFACE EXPENSES—							
Labour.....	2241	13	3	4	5.004		
Supplies and Stores.....	133	11	11	0	3.157		
Transport of Ore.....	37	9	4	0	0.885		
Tools.....	21	4	5	0	0.496		
Repairs.....	14	12	6	0	0.345		
General Expenses.....	115	14	10	0	2.736		
Fuel.....	152	4	10	0	3.599		
Office Expenses.....	585	9	7	1	1.843		
Management.....	208	4	11	0	4.924		
Assaying.....	23	16	8	0	0.563	6	11.552
	2534	2	3				

per ton
mined
(10,556).

per ton
milled
(10,150).

TABLE II.—YEARLY SUMMARY OF MINE WORKING COSTS.

TON- NAGE	MONTHS.	LABOUR.		FUEL.		WATER.		SUPPLIES.		TOOLS.		REPAIRS.		GROSS COST.	
		GROSS.	PER TON.	GROSS.	PER TON.	GROSS.	PER TON.	GROSS.	PER TON.	GROSS.	PER TON.	GROSS.	PER TON.	TOTAL.	PER TON.
1241	January	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
739	February	257 0 8	4 1 71	105 12 6	1 8 43	94 1 6	1 6 10	19 0 8	3 68	4 19 8	1 26	4 19 8	1 26	430 15 0	7 8 07
732	March	140 15 1	4 0 62	66 17 10	1 9 72	103 5 0	2 9 53	19 9 4	6 33	3 16 0	1 46	3 16 0	1 46	343 3 10	9 3 46
689	April	142 7 1	3 10 19	66 0 0	1 9 64	77 15 0	2 1 40	19 7 1	6 34					323 10 7	8 3 66
776	May	152 6 8	4 1 59	74 3 0	2 1 82	74 0 0	2 1 79	26 13 2	9 28					331 8 3	9 7 44
721	June	148 10 10	4 1 45	61 12 0	1 7 92	81 10 0	2 1 20	21 18 10	6 79					356 6 15	8 4 03
739	July	159 11 8	4 1 52	66 0 0	1 9 70	52 15 0	1 5 56	17 15 3	5 01	3 9				325 10 6	7 8 24
732	August	165 8 4	4 2 12	77 5 0	1 11 49	75 15 0	1 10 39	15 5 1	5 01	1 10 0				354 5 15	8 7 33
922	September	143 14 2	3 1 41	71 0 0	1 6 47	86 0 0	1 10 39	15 5 1	5 01	1 1 6				334 5 1	4 10 18 4
995	October	143 15 6	3 1 00	73 0 0	1 6 15	89 15 0	1 10 39	15 5 1	5 01	3 07				348 10 6	7 6 72
1035	November	148 10 8	4 2 10 55	122 0 0	2 4 30	109 15 0	2 1 44	31 0 8	7 19	13 6				369 2 3	7 7 80
868	December	136 4 7	3 4 46	99 0 0	2 2 73	100 15 0	2 5 78	29 5 1	8 69					327 8 11	9 3 82
10150		1883 8 3	3 8 510	1037 18 4	1 10 170	1005 11 6	1 11 777	335 8 9	7 931	6 10 1	1 15 151	0 1	3 579	4318 17 0	8 6 12

TABLE III.—MILL ACCOUNT.
GENERAL ANALYSIS OF COSTS.

MONTHS.	MILL MEN.		AMALGAMATORS.		BATTERY-MEN.		FEEDERS.		ENGINE DRIVERS.		VARIOUS ATTENDANTS.		GROSS COST.		COST PER TON.
	Wages.	Shifts.	Wages.	Shifts.	Wages.	Shifts.	Wages.	Shifts.	Wages.	Shifts.	Wages.	Shifts.	TOTAL.	PER TON.	
January	£ d. s.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
February	29 0 0	57 1/2	38 6 8	79	39 10 0	75 1/2	37 15 0	1 79 1/2	52 15 1	14	5 16 8	2 1 8	496 15 9	140 17 6	1 1
March	34 0 0	51 1/2	34 6 8	85 1/2	42 10 0	72	36 5 0	54 1/2	30 3 4	5	2 1 8	1 8	142 7 1	152 6 8	1 1
April	27 0 0	29 1/2	19 10 8	50 1/2	29 17 6	56	28 0 0	54 1/2	36 10 0				148 10 10	150 11 8	1 1
May	26 0 0	27 1/2	18 8 4	58 1/2	29 8 9	65	32 10 0	54 1/2	36 10 0				148 10 10	150 11 8	1 1
June	26 0 0	29 1/2	19 15 0	58 1/2	29 2 6	73	39 0 0	54 1/2	34 13 4				148 10 10	150 11 8	1 1
July	26 0 0	29 1/2	20 8 4	61 1/2	30 10 0	78	39 0 0	54 1/2	37 6 8	13 1/2	6 17 6	4 17 6	148 10 10	150 11 8	1 1
August	28 0 0	30 1/2	20 10 8	63 1/2	31 17 6	81	40 10 0	56 1/2	33 3 4	8 1/2	6 17 6	4 17 6	148 10 10	150 11 8	1 1
September	26 0 0	28 1/2	16 8 4	53 1/2	26 16 3	73 1/2	36 18 9	49 1/2	34 6 8	6	3 0 0	3 0 0	148 10 10	150 11 8	1 1
October	26 0 0	28 1/2	18 8 4	57 1/2	28 15 0	76 1/2	38 0 0	51 1/2	34 6 8				148 10 10	150 11 8	1 1
November	26 0 0	28 1/2	19 0 0	57 1/2	28 10 0	78	39 0 0	51 1/2	34 6 8				148 10 10	150 11 8	1 1
December	27 0 0	29 1/2	17 5 0	49 1/2	24 18 9	66 1/2	34 17 6	48 1/2	32 3 4				136 4 7	136 4 7	1 1
328 0 0			263 13 4		370 16 3		441 1 3		402 1 0		22 3 4	54 12 4	1882 8 3	38 510	3 8 510

TABLE IV.—MILL ACCOUNT.
ANALYSIS OF LABOUR.

MINE REPORT.										REMARKS.
MINE WORKINGS—		Sunk or Driven during month.		Total		Width of Vein.		Av. Assay Value.		Tons Milled.
		Ft. In.		Ft. In.		Ft. In.		\$ Per ton		
TONS MILLED. APPROX. GROSS COST COST PER TON MILLED										
MINING ACCOUNT— Sinking Driving Stopping General Explosives Stores and Materials										
MILLING ACCOUNT— Wages Stores and Materials										
CYANIDING ACCOUNT— Wages Chemicals Stores and Materials										
FUEL ACCOUNT— Cords used Cords Stacked										
GENERAL ACCOUNT— Engines and Foremen Clerking, Assay and Office Freightage, etc. General and Incidental Stores and Materials This month In previous months This year, Total										
CAPITAL ACCOUNT— Development (mining) Surface (labour) Prospecting (labour) Materials and Plant TOTALS										

MILL REPORT.											
PERIOD.		Hours Run.		Tons Milled.		BAR GOLD		CONCENTRATES.		TAILINGS	
						Weight. Approx.		Weight. Value		Assay value per ton	
						Oz. dwts		Tons dwts grs		\$	
This month											
In previous months											
This year											

CYANIDE REPORT.									
PERIOD.		Tons Treated.		ASSAYS.		EXTRACTION.		SMELTED BULLION.	
				Before. After.				Weight. Value	
								Oz. dwts.	
This month									
In previous months									
This year									

SUMMARY OF WORKING COSTS.									
DEPARTMENT		This Month.		Cost per ton		In previous Months.		Cost per ton	
Mining account		\$		\$		\$		\$	
Mill account									
Cyanide account									
Fuel account									
General account									
Total									

STORE AND KITCHEN.		MONTHLY WAGES AND CASH RECEIPTS.		REMARKS	
		Dr. Cr.			
Cash sales		\$		Total wages for the month	
Cash in hand				Other payments as per vouchers	
TOTALS				Outstanding accounts	

TABLE V. FORM FOR MONTHLY REPORT AND WORKING COST STATEMENT OF A SMALL MINE, AS EMPLOYED BY MR. CHARLETON.

Tables VI. and VII., pages 698 and 700), eventually posting the various accounts opened in each month into a general costs ledger.

Detailed information of the progress of the workings can be obtained or calculated for the year and analysed from the data supplied by the Working Expenditure form and Mine Working Statement (when these have been properly filled in month by month).

In some cases it is of course necessary to keep separate track of contract work and of work done on day-pay, or of work done by hand, as distinguished from work done with machine-drills. In others, it may be desirable to ascertain the cost per cubic foot or per ton of rock stoped, as compared with the cost of each cubic foot or ton of ore obtained, to show the proportion between ore and waste mined; for which purpose the Mine-Working Statement can be used, if the "average width stoped," be entered, in substitution, in the column headed "width of formation" (page 688).

Where fractions of men's time have to be subdivided, or costs have to be reckoned on any given unit, such as tons milled or feet driven, the money value they represent should be carried out decimally to two or three places of decimals of a penny or cent, to avoid disagreement (amounting, it may be, to several pence or cents) in totalling different items. No stores should be delivered without a proper requisition, which may be supplied to the different foremen or heads of departments, as Mr. Hardman suggests, in the convenient form of a pad, each form being stamped with a consecutive number.

The store-keeper may keep the stores book and stores-delivery books, or make a daily report on slips to the office. In the latter case, the account of stores received and delivered should be kept in the head mine office, which is perhaps to be preferred, all freight and transport charges, together with the cost of handling and distributing stores, being thus easily added at once, *as they must be*, to the invoice cost price of all goods entered in the stores books, so as to show the actual cost-price at the mine of each article charged against the various accounts in the stores ledgers or cost minute books.

Company's stores, kept for supplying the workmen with necessities, such as food or clothing, are of course entirely separate from these supply accounts.

All general stores should be kept in a closed store-building, which should only be open at stated hours in the morning, mid-day, and evening. To prevent waste and pilfering, stock should be taken periodically, and Mr. Hardman gives a form of general ticket, which can be kept on the bin or rack in the store-room or on file in the store-room

DAY.	Candles.	Dynamite.	Fuses.	Shanks.	Steel.	Drill Parts.	Handles.	Shovels.	Spikes.	Nails.	Soap.	Time fuse.	Labour.	Ore.	Waste.
1 S	4	5	10	104	321								\$14 02 1/2	18	7
2	4	5	12	104									12 00	18	5
3	4	5	12	96									10 07 1/2		12
4	4	5	10	73									8 30		15
5	4	5	10	73									11 70		15
6	4	5	10	73									9 70		
7 S	4	5	10	60								50	10 05		
8	4	5	10	60									9 00		
9	4	5	10	114									11 34		
10	4	5	6	52									7 00		
11	4	5	10	61									7 00		
12	4	5	10	61									8 35		
13	4	5	10	61									8 35		
14	4	5	10	61									8 35		
15 S	4	5	10	61									8 35		
16	4	5	10	61									8 35		
17	4	5	10	61									8 35		
18	4	5	10	61									8 35		
19	4	5	10	61									8 35		
20	4	5	10	61									8 35		
21	4	5	10	61									8 35		
22 S	4	5	10	61									8 35		
23	4	5	10	61									8 35		
24	4	5	10	61									8 35		
25	4	5	10	61									8 35		
26	4	5	10	61									8 35		
27	4	5	10	61									8 35		
28	4	5	10	61									8 35		
29 S	4	5	10	61									8 35		
30	4	5	10	61									8 35		
31	4	5	10	61									8 35		
Totals.....	104	130	103	1411	28		2	4				100	\$49 30		186
Prices.....	.11	.16	.045	.03	.14		.10	.81				.005	\$32 47		
Proportion for Superintendence.....															
Total Labour.....															
Total Supplies.....															
From Power Account (Drills).....															
From Power Account (Pumps).....															
Total.....															
Sunk 40 ft. 6 in., cost \$10.125 per foot.															

TABLE VI.—FORM FOR RECORDING AND ANALYSING PROGRESS IN SNAFT SINKING. BY COURTESY OF JOHN E. HARDMAN, ESQ.
The same general form serves for records of stopping, with slight change in the headings of the subdivisions.

office, which will facilitate this operation. This ticket should be checked weekly by the clerk in the office from the stores book.

All classes of articles and materials used about the works, needless to say, should be kept in stock. It is perhaps a somewhat open question whether costs, such as office expenses, umpire assays, advertising, express and mint charges on bullion, insurance, taxes, and legal expenses, which bear a varying ratio to the output or amount of work done, should simply be shown separately under the head of General Expense Account (as is usually done), or whether, as Mr. Hardman advocates, they need to be distributed in the cost minute book to different branches of Mine, Mill, or Capital Account, against which they may be properly chargeable; but, no doubt, if a manager will take the trouble to carry it out, this is really the proper plan.

In the same way, whilst management, pumping, hoisting, etc., should unquestionably be shown separately, it is undoubtedly true that, in order to show accurately the actual cost of doing a certain piece of work, a proper proportion of such costs should be charged in the cost minute book, or general costs ledger, against the various jobs into which they enter as items of cost. This can be done in several ways, as described by Mr. Hardman, of which he gives an illustration in his valuable paper. Another form given by the same author, reproduced in Table VII., page 700, is an excellent example of how the power account should be dealt with and subdivided in the cost minute book; great laxity is usually shown in keeping track of this department, and such a system, properly carried out, frequently results in making possible economies previously unsuspected.

Tally should be kept of every pick or hand or machine-drill pointed, to determine the cost per point and charge the right amount to the different jobs in progress underground and on the surface; whilst all fuel sent to the shop must be weighed and charged against it, as also steel and other material requisitioned from store, which, after it is used, is credited to the shop and debited to the account for which it is employed. Stock should be taken at least once a year of all iron, steel, etc., on hand at the smithy, when it can be rounded up and weighed.

A carpenter or machine-shop account should be kept on the same lines as that of the blacksmith's shop.

Where ore is trammed from a mine direct to the mill, such tramming-charges are figured on the basis of the total number of tons trammed, and generally come under the head of Milling or Surface Expenses; but where ore is shipped, its shipment may be charged under mining-costs.

[illegible]

By keeping a shift-record, a manager is enabled to arrive at the production per single shift, or per man at work, which is often highly instructive. To do this, the shifts expended on a given piece of work in a given period (say a week or month) are divided by the unit of work (such as tons produced, feet driven, or tons trammed) which they represent, and compared with results of a similar kind; and as Mr. Hardman points out, "a cardinal point in the subject of costs is the ratio between producers and consumers, producers being labour which is *directly* engaged in producing material from which revenue or income is derived, such as men stoping or developing, whilst consumers may be classified as those who simply handle the valuable material produced, without increasing its amount, such as trammers and all surface men. The smaller the proportion of consumers, the more profitable the mine; the larger this proportion gets, the less the profit becomes. The percentage of cost which labour and other items, such as fuel, water, explosives, etc., bear to one another at different mines in the same district, and in one district as compared with another, is another point to be looked into and studied, in order to ascertain the cause of differences that are frequently found to exist and to determine whether they are preventable or not.

As the manager must oversee building and machinery plans, surveying, etc., a well-equipped drawing office is indispensable to a large mine. Drawings of different kinds should be classified and kept apart, and a record of each drawing, which should be distinguished by a number, should be kept for reference. The planimeter and slide-rule are time-and-labour-saving appliances that can be and are employed with advantage in well-regulated large offices, not to mention the pantograph or eidograph, for reducing or enlarging scale drawings. Solar-printing is a useful and economical auxiliary in this department, for copying tracings. I will only add that all surveys, assay-plans, etc., should be brought up to date monthly, and a tracing should be sent home quarterly, if not more frequently.

The manager's concern with contracts, specifications, etc., must be still more summarily dismissed. All I need say is that it frequently embraces legal business, which at times necessitates the assistance of a solicitor, and in some cases requires knowledge and consideration of various systems upon which work is paid for—such, for example, as the lease or tribute-system, extensively used in Colorado and elsewhere.

In conclusion I would say, as I took occasion to remark some years ago in discussing the cost of milling in different localities, "*The ef-*

iciency of the general management is the master-key to the success of a mining undertaking." If the workman is to demand and obtain high wages in the future, it will only be rendered possible by employing high-class technical and business skill in the management and conduct of operations, so as to take advantage of every practical and scientific improvement which tends to cheapen the aggregate cost of production, and in duly proportioning wages in all departments to relative efficiency and usefulness, whether in respect of mental attainments or manual dexterity. Unskilled labour, in fact, can no more hope to compete with skilled workmen living in comfortable circumstances (although highly paid) in a field such as mining, where skill is essential, than the skilled workman can expect to banish cheap labour from a field where nothing but slight manual effort and intelligence are needed.

The only certain proof of economy in administration is the ratio which the cost of handling and treating a given tonnage of ore bears to the percentage of gold or other valuable product saved, when compared with the cost of doing so under similar mining conditions elsewhere; gross cost, which is governed by local wages, rates and numerous other circumstances, is no criterion whatever to gauge it by.

Discrimination in employing the right man and the proper material or machine in the right place is the pivot on which management turns; although it amounts in the former case simply to the knowledge when it will pay to put on an extra man at a profit, and when to knock one off the pay-sheets; where to employ a mechanic, and when to make shift with a labourer. Where you have to deal, as you must in any large undertaking, with the three different factors of brain, manual skill, and muscle, it is not less ridiculous, for instance, to place a man who may be an adept in cobbing ore in charge of a mill, with the salary of a first-class mill-man, than to put the latter to run a stone-breaker, at the wage of a labourer.

No one can doubt that the question of mutual and fair adjustment of profit, as between the two co-important trade factors of capital and labour, so that both can exist in harmony, is fast becoming the problem of the hour, as it certainly will be of the next century; and the chief prop on which the future of the miner and the capitalist alike depends is in the application of technical science, and the careful selection of the men and machinery employed about a mine, with a view to cheapen production as much as possible.

COST KEEPING: A SUBJECT OF FUNDAMENTAL IMPORTANCE.

By James Newton Gunn.



TO say that cost keeping is a subject of fundamental importance seems to be offering a statement which, of any that might be presented to a manufacturer, is most trite. Any manufacturer will agree with such a brilliant generalization. Having discharged his whole duty by agreeing with the proposition, he becomes a member of that large majority into whose hearts has not entered even a suspicion of what is involved in really finding costs.

Cost finding is not merely the work of an accountant, no matter how competent he may be. It is the work of an engineer, supplemented by the best accounting knowledge that he can command. The engineer in turn must be possessed of an executive faculty to such a high degree that he shall be able to create and administer an organization, which not only finds, but shall continue to find, costs. Having found the costs, this executive must be possessed of a sufficiently broad knowledge of that portion of the industrial world to which he is related to be able to use the information which he has, and to preserve such an organization as will insure facts for each succeeding month or year being presented in like manner with those first compiled, so that he may receive the full benefit of comparison. For costs have no value except in comparison, that action may be directed by experience.

Therefore the first essential of a system of cost keeping is that the work of the organization shall be up to date, so that the facts presented may be used before the conditions shall have so changed, or the interest of the executive in the particular matters under consideration shall have so far waned, as to make the information of no value.

The second great essential for effective cost keeping is predicated

The term "cost-keeping" is misleadingly narrow. The science which forms the foundation of intelligent advance in the economy of production deserves a more fitting name—deserves recognition as itself a specialised branch of engineering effort. Mr. Gunn draws clearly the outlines of the province of the "production or industrial engineer." The concrete application of his specialty to particular works forms the literature of which *THE ENGINEERING MAGAZINE* is a great current library. A concentration of this literature, prepared by Mr. Gunn and other leading specialists, will be found in "The Complete Cost-Keeper," just issued from *THE ENGINEERING MAGAZINE PRESS*.—*THE EDITORS.*

by the first. Manifestly, to insure prompt returns, the general organization of the factory, or whatever the industrial undertaking, must be so complete as to prevent delays in the presentation of the general results. This matter of general organization is so essential to cost keeping that cost keeping really becomes a detail in the larger question of factory or industrial organization, which question must be solved before any solution of the other can be made. Frequently I have had occasion to liken a fully-equipped factory to a man well-trained for his particular duties, skilled in many things, having a multitude of duties to perform, each member of his body properly developed, working in harmony with the other members, and all controlled by the general executive, the intellect. In a large factory the manager, the intellect of the establishment, must have a system of records, machines, and men, which serve respectively as his nerves, bones, and muscles. Any derangement of the nerves means a failure to communicate properly to the muscles the will of the intellect; therefore this nervous organization of the factory must first be created. The very term "factory or industrial organization" indicates what must be done. There must be:

1:—A clear definition of the departments of business, that similar work and similar functions shall be grouped in one department.

2:—A positive definition of duties of each department and its relation to the general business.

3:—A clear fixing of the responsibility and a willingness to have responsibility rest with the heads of the various departments.

4:—Scrupulous care to communicate the various wishes of the chief executive, through the proper channels, that the responsibilities fixed may be preserved and each department limited to its particular functions and for the specific purposes of cost keeping.

5:—A harmonizing of the commercial accounts, that is, the representative accounts of the business, with the general scheme which is to be followed in the factory-accounting or cost-keeping department. To be more specific: the representative accounts in the private ledger should be such as to present certain statistics as to aggregate amounts of various classes of indirect expense and the direct expenditures, so as to show the relations between these various classes and to provide means for checking the results or the accuracy of the detailed costs elsewhere determined. The plan for the commercial accounts must include closing monthly the loss-and-gain statement of the various operations of the business.

6:—A proper head to the department of cost keeping, who must be as much engineer as accountant and capable not merely of compiling

figures, but of using the information when the facts are compiled; for the end of cost keeping is cost reduction. This man must be so efficient that he may be depended upon by the highest official of the company and he will naturally be high in the councils of the latter. Much condemnation of really efficient cost keeping comes from the inability or failure to use the information which is extant. A man who fills such a position will have no sinecure.

The third essential to accurate cost keeping is the positive determination of final results which are to be secured. A seeking from the start for definite ends will frequently eliminate much unnecessary work in the developing of any plan, and prevent the expanding of one portion of the work beyond its due limit and the treatment of another portion in a superficial manner. For illustration, let us assume a representative establishment in which the gross annual expenditures are \$600,000, of which \$200,000 is spent for direct or productive labor, \$200,000 for direct materials, and \$200,000 for all indirect expenses of the business. These proportions it will be found are essentially correct. Most schemes of cost keeping will devote, in such an establishment, about \$6,000 to all of the work incidental, directly or indirectly, to getting costs; and of this amount about \$3,500 will be devoted to tabulating information about the labor, or one-third of the gross expenditures; and \$2,500 to material and indirect expenses, or two-thirds of the gross expenditure; and yet the direct labor is the portion of the expenses which can be least readily reduced and about which the natural conditions under which the expenditure is made will make it most easy to get accurate information.

The criticism of the eventual usefulness of the information finally secured may thus determine the amount desirable to expend, or necessary to expend, in getting these results. It may often be found that a predetermined plan to give costs in extreme detail will be abandoned when examined from the standpoint of determining how much detailed information the executives are able to use, leaving to some future date the development of the system so that when the detailed information is secured it will be used. A clear definition of a plan of cost keeping will have the further advantage of making it possible for the chief executive to insist on the preservation of the organization from any modification without his authority.

It would be quite proper to expect of a system of cost keeping:

1:—Final costs; that is, the costs of completed units of the product at the door of the factory, and final costs in which to these factory costs are added all commercial and selling costs.

2:—Partial costs; that is, costs of certain component parts of machines, or costs of steel or brass at certain stages of their production.

3:—Comparative costs; that is, between the costs of one period and another, and the costs of like articles as produced in different plants under control of the same corporation.

4:—Costs by operations; that is, the direct labor costs, so that it shall be possible to change from a day basis of remunerating labor to some form of a piece-work basis. These costs by operations should likewise be comparative from one period to another, in order to show the results of modified methods of manufacture, modifications in the system of remuneration, or the results of combination of two or more operations into a single operation.

5:—Indirect costs by classes and groups weekly: by this it is intended that a definite schedule or classification of the various indirect expenses in any undertaking shall be made; and that costs compiled under this classification shall be the basis for considering any modifications from the general scheme in administration of the factory, the modification of the plant, or the modification of such indirect-expense operations as shall effect a direct saving. The result of such tabulation of indirect costs should give the basis for accurate distribution of indirect expenses upon the direct factors of cost, in some manner that shall be more equitable than the old and common method of arriving at a percentage relation. The present practice of using this percentage basis of distributing indirect expenses very frequently includes the practice of using one expense rate for a period of a number of years, and the frequent disregard of the variations of expense rates throughout the various departments of the plant.

Some of the results of an effective system of cost keeping, in addition to enumerating costs as above, should be that it should show how large an investment in material is permissible, and, combined with effective factory organization, it should keep the efficiency of that investment as high as possible.

The fourth requisite of an efficient system of cost keeping lies in such an organization of the factory as will centralize under one storekeeper the control of all material expended by the manufacturer. Very many manufacturers will argue that because their material is not liable to depletion by theft, from the lack of its value to an individual, they may safely figure their costs on the basis of a theoretical schedule of the material that should enter into any given unit of their product. While in some cases this may be true, it is a fair rule that such a plan fails to account for loss in waste or scrap that occurs in every manu-

facturing operation. It also fails to account accurately for the material which forms, in the majority of cases, an important item of indirect expense. The plan of having a general store-keeper does not necessarily mean that the material under his control shall actually be stored in one place, but may in fact be distributed as the exigencies of the business demand. A general store-keeper will, in addition, be an important factor in cost reduction, through obviating losses and delays arising from not having the proper material on hand for the completion of a given order, and he will largely prevent over-stocking of material and the consequent unnecessary investment in materials.

The last of the principal essentials to an effective system lies in the completeness with which any scheme is executed. Many general managers feel that it is sufficient to take the report of a trusted lieutenant as to why their scheme of cost keeping is not efficient. Cost keeping is of such paramount importance that this is not a thing to be entrusted to any assistant, however, excellent he may be. Some of the most satisfactory systems of costs that have passed under my notice have been valuable because of the most excellent organization and the degree of careful administration given by the chief executive, and yet some of the systems that produced these satisfactory results were by all laws of criticism cumbersome, inefficient, and inadequate. Experience has borne witness to the converse of the proposition, and there exist several notable examples of carefully-worked-out plans for cost finding which are worse than useless, because the real heads of the business have delegated their administration to a clerk, or a fairly good commercial accountant, or to a general manager, who is valuable, not as a manufacturer, but as one skilled in marketing the product. To expect in establishing a scheme of factory organization and costs that its results will be forthcoming within a few months will be wrong, as the best plan can be evolved only after many months, and perhaps years, of painstaking development and modifications of the general scheme. It is essential, further, that the one having charge of costs shall have full access to the most private information of the company, else in his indirect expenses the costs will give results which are at best approximations, and no matter how close, will be inaccurate.

It is impossible, within the limits of this article, to do more than offer general principles, and therefore to deal with mechanical devices or methods for the scheme of records is impracticable, even if it were desirable. It is undesirable because no example which would embody specific forms and methods could be even broadly suggested, as the conditions which surround the cost problem in different industrial un-

dertakings, even if the product or object is similar, are so many and various that the same scheme would in no way be satisfactory or applicable. In general, however, this has been proven; that for quickness in presenting results, the elimination of duplicate records, the prevention of errors in transcription, and the insuring of dealing with original records, the card system is best.

A proper system of costs must be depended upon to furnish the information on which shall rest the judgment of the chief executive in determining the remuneration of the employee. Our best students of the labor problem believe that four out of five of the instances in which difficulties have arisen in acute form between employer and employee, could have been avoided had the employer been properly equipped with real facts regarding the productiveness of the individuals on his payroll, and had he used this information for the establishment of such a basis of remuneration as would have rendered to the individual an increasing return per day in exchange for increasing productiveness.

Labor has constantly suffered from the ignorance of capital concerning its own ventures. Capital has likewise so suffered, and while all manufacturers agree that a knowledge of the operations of the business is of paramount importance, they are inclined to scrutinize out of all relative proportion those expenditures required to give them these results. They further are slow to enter into a scientific investigation of the facts presented in their own business, becoming impatient of final results and refusing to recognize that each manufacturer must, to a large degree, in solving the problem of costs, solve the problem of the economic relations of the investor and the laborer. This problem yields only to long pains-taking study. I believe so thoroughly in the fundamental importance of cost keeping and factory organization as to proffer this suggestion: that while engineering today has, as its recognized representatives, civil, mechanical, mining, and electrical engineers—those who deal rather with processes and mechanical methods—yet there exists a science which only awaits the creation of a literature to have its own existence recognized as a new department of engineering. Our various industrial organizations are successful directly as their executive or administrative heads have made a study and application of the principles of that science, which may be termed the science of production. The successful manager has himself become a member of this existing, but as yet unrecognized, engineering profession. The discovery, study, and collation of the facts, and the enunciation and application of the principles of this science, are the work of the production or industrial engineer.

THE MECHANICAL AND COMMERCIAL LIMITS OF SPECIALISATION.

By J. Slater Lewis.



WHILST it is quite evident that there must exist definite commercial and mechanical conditions beyond the limits of which specialisation will cease to be profitable, it is not easy to define these limits in so many words on account of the extreme complexity of the question. Moreover, specialisation being essentially a process of evolution, it is not at all certain that its tendencies can be controlled, or that its developments will always be on the side of even-handed progress.

The mechanical limitations, whilst absolutely hinged upon commercial considerations, are much more simple and capable of formulation than the latter. Given quantities sufficient and a steady demand, mass-production follows as a matter of course. This observation suggests, however, that a systematic treatment of the subject would include consideration not merely of the natural conditions favouring specialisation, but also of conditions artificially brought about with the same object consciously kept in view. In other words, the conditions limiting specialisation will be best studied by an examination of the conditions favourable to its development.

Mechanically considered, the subject has very sharply defined boundaries. On the one hand, there is the condition of things obtaining before repetition work was known, when every single part of every single machine had to be separately made and individually fitted, and on the other a mechanical millenium, in which all possible ele-

An American, viewing the works of a leading Swiss manufacturer of machinery, commented upon the great range of work—marine construction, steam engines, hydraulic appliances, electric motors, general machinery. "Would you not manufacture much more cheaply if you specialised on one or two of these lines?" he asked. "Possibly," was the reply, "and lose far more through the fluctuations of demand in our comparatively circumscribed market. Now, if steamboat building is dull, our electrical work may keep us running full-time; if both are slack, factory and mill engines are likely to furnish abundant work. Steadiness of business means more to us than ultra-specialisation." The question whether this steadiness should be secured by extending the range of work done in the factory, or the range of the market in which the factory product is sold, is an engrossing one, and one which must be specially determined by the conditions of each special case. Mr. Slater Lewis reviews the ultimate considerations entering into the problem.—THE EDITORS.

ments of a machine will be the separate productions of highly-specialised industries, and the task of the machine designer will be to combine these, and the work of the machine builder will be confined to purchasing and putting them together. It will be recognised that this degree of specialisation has already been nearly realised in connection with architecture and building. Yet there was once a time when the builder shaped as well as used his materials.

Although in engineering work we are as yet far from such an extreme development as is here assigned as the ultimate limit, it will yet be permissible to claim that we are at least well launched on this path. Many of the elements of mechanical combinations are already so highly specialised that it does not pay the engineer to produce them for himself, under any ordinary circumstances. Gear wheels, shafting, hangers and fittings, certain kinds of nuts, bolts, and screws, lubricators, pressure gauges, and practically all electrical appliances may be cited as examples. It is a truism to say that this class tends to increase.

The influences which tend to such increase cannot be called mechanical. They are almost wholly commercial—questions of extent of and the access to markets. Of course, the demand in the first instance arises from a degree of uniformity in the use of any given appliance, but this, though a technical, is certainly not a mechanical question so far as the production is concerned. On the other hand, the actual production of any mechanical element on a large scale with a consequent advantage in price, uniformity of product, or other hitherto unattained excellence, may create a demand where none existed before, and this is, in fact, the usual history of new specialisations. By creating a demand is here meant forcing the general adoption of some one standard type to the exclusion of local varieties.

As regards the mass production of any one comparatively simple article, there are, then, practically no mechanical limitations. The controlling considerations are technical adaptability capable of extinguishing, by balance of advantages, all slight individualities of design; all the rest are pure matters of commercial wisdom and opportunity.

In the case of machines, on the other hand, or of any contrivance consisting of a number of organic parts and having a range of sizes or powers, mechanical considerations begin to weigh upon us. Just as the manufacturer of a single specialised article tries to produce a design which will supersede as many small varieties as possible, so the maker of a range of machines will strive to have as many parts

as possible common to several machines. But this standardisation is, perhaps, the least of the problems involved. Its advantages are so obvious that it is not a point likely to be under-rated. The question of the special machine, designed and built for production of one element only of the whole, is a far more debatable one.

The mechanical limits of specialisation in any given product will evidently have been reached when no further standardisation of parts can be attained without sacrifice of technical efficiency, and when all the machines in use are special machines each producing one article, and one only, more cheaply and satisfactorily than it could otherwise be produced. The critical point is the determination, for any given piece, when it will pay to devote a machine wholly to its manufacture when such machine will have to stand idle for part of its time. The problem of adopting a machine that can be filled with work is an easy one to adjudicate upon; to know just when to employ a machine that must perforce lie fallow for more or less doubtful periods demands a fine judgment.

The commercial considerations limiting specialisation are much more numerous and important than the mechanical. The ultimate appeal in all these matters is to the arbitrament of competition. The reason why specialisation has such surpassing interest for the engineer to-day is because the engineering industries are at that particular phase of evolution in which specialisation presents the most vigorous weapon of competition available. To competition by specialisation there is no possible answer but equal or further specialisation. It is in the nature of things a temporary or passing phase, yet with the most rapid progress possible, its possibilities will not be exhausted in our time. But where rivals are already trying to occupy the same field in which there is not room for both, the superiority will obviously remain with that one who has the balance of conditions in his favour. Now, it is much more probable that mechanical conditions will be equally balanced than that commercial conditions will be. For this we have to thank the spread of technical education, the chief use of which is in averaging technical conditions.

By technical education is not meant, however, the set curriculum of the technical school. This provides merely the groundwork on which further progress may be built. The true technical education of the engineer lies in the free interchange of experience by the medium of the technical press, the papers read before learned societies, with the discussions they elicit; the throwing open of works to the expert on his travels, and kindred methods by which the news of

progress circulates throughout the world. The effect of all this is undoubtedly to average up the standard of practice the world over, and to make purely mechanical conditions equal between intelligent competitors in the same special line.

As regards commercial conditions there is no such opportunity of availing one's self of the results of others' experience. The manufacturer who has discovered a new channel for the disposal of his productions does not call upon his rivals to admire his cuteness. On the contrary he keeps all such matters in the profoundest obscurity that he can manage. In some cases precautions almost bordering on the grotesque are taken to keep the knowledge of the destination of orders confined to as few officials as possible. The result is that notwithstanding the cult of the technical school, the real arena on which the survival of the fittest is fought out is and will remain the commercial one. The bearing of this on the question of specialisation is obvious. Sufficient grasp of commercial conditions to know when it will pay to sink capital for the purpose of forcing the market's consumption of any article is the possession of very few. The reward of success is very great, but the risks of faulty judgment are far heavier than in the case of an ordinary enterprise. One of the principal reasons for this lies in the stereotyped character of the productive elements of high specialisation. A plant which is arranged for production of some specialty, for which after all there is not sufficient commercial excuse, becomes a very heavy clog on its possessor. The commercial limitations are thus seen to be very serious and rigid, and to deal successfully with them demands exceptional study and mature consideration of all possible contingencies.

Thus far the question of rivalry as between equally-placed competitors has alone been considered. There is, however, a much wider view than this which needs attention. It has already been said that the secret of successful specialisation lies first in the existence of a possible market large enough to absorb the proposed production, and secondly in properly-directed efforts to obtain access to it. Now, though there is only one natural market, whose limits are coincident with those of the civilised portion of the world, the effect of political divisions is to convert that simple area into a very patchwork of subdivisions. A fiscal map of the world would be a most interesting study, and perhaps might be regarded as a monumental example of the shortsightedness of humanity at this particular stage of its development. But however mistaken the policy of high walls and jealously-guarded boundaries, there seems little prospect of its modi-

fication at the present time; we have therefore to consider the effect of these artificial barriers as they actually exist.

A study of the actual influence of the establishment of the German zollverein and the iron wall of the American tariff on the power of competition in foreign markets, by reason of the wide base free from outside interference which this policy of exclusion provides, would be a most interesting one to make. The nursing of nascent industries by a protective tariff is at least a process too frequently justified to be called in question. That the State adopting it loses more than it gains is one of those fetishes of political economists that seem to owe acceptance to ferocious assertion rather than demonstrated reality.

Without, however, losing our way among these bye-paths of theory, we may regard the matter in a light that is at least suggestive. In the matter of specialisation it is fairly evident that a manufacturer operating within the limits of a tariff zone will be enabled to produce from the very first on a large scale, and to this extent will be in a more favourable position to compete with his surplus production in foreign markets. The British manufacturer, on the other hand, has no such home preserve in which to gather strength. He has from the first to try and occupy his own market, already over-run by the surplus production of his foreign competitors. Any remaining energy he may have left is to be devoted to competition with those same rivals in neutral markets, with all the disadvantages which production on a smaller and more uncertain scale gives as a handicap.

It is not always the conservatism of the British manufacturer that is to be blamed for his hesitation to adopt methods that are confessedly giving the American the cream of this particular class of work. The range of the British and the American manufacturer is too often so dissimilar as to make the methods of the one of doubtful advantage for the other. How many American and how many British manufacturers have access to the markets of both countries? The answer to this question, if thoughtfully considered, will explain a good deal of the mystification which has grown up around this vexed subject of discussion.

It was suggested at the outset of this article that specialisation, regarded as a growth or course of evolution, might not necessarily always prove to be on the side of progress. We have an example of this in the reproach which was at one time universally and is to-day occasionally conveyed by the utterance of the phrase "machine-made." Ugliness and monotony were considered inseparable from machine productions. Time proved that this was not really so, but the com-

plaint was true at that period. Although a matter of æsthetics is somewhat outside the province of the engineer, a parallel line of argument will sometimes hold good. Specialisation leads essentially to uniformity, and uniformity means the starving out of individuality. Stereotyped conditions may thus eventually be set up which will react harmfully on progress. To watch for this danger does not, however, fall in the province of the specialiser; he is not able to look to ultimate effects, for his interests are of necessity centered in the present period of transition.

Whilst it is true that specialisation leads to a gradual transfer of operations from the hands of the engineer to those of the manufacturer, it must not be lost sight of that the manufacturing of engineering articles is somewhat different from any other. These articles are not in themselves prime objects of consumption like silks or condensed milk. They are themselves only factors or organic elements in productive processes.

It is evident from this that subdivision into separate trades or industries will have a limit imposed by technical considerations, beyond which it will not be possible to pass. The ultimate subdivision being in itself an organic piece, it will be necessary for the manufacturer to keep constantly in view the technical conditions subject to which it functions. This will always prevent subdivision going to such extreme length as we find in the Birmingham trades, wherein there are manufacturers devoting the whole of their attention to the production of a single class of article, and that in perhaps only one or two varieties. It is evident that the manufacturer who is a specialist in "pepper-caster tops" is not oppressed with any very serious technical conditions of use which have to be permanently kept in mind.

Far otherwise, however, is the case of the specialiser of mechanical appliances, even of the simplest and most widely-applicable class. It is not for him to rest and contemplate his labours when he has equipped and started his plant, though it be only for shaft couplings. In an article of ultimate consumption there is no progress to keep constant reckoning of (who ever improved a "pepper-caster top" or a thimble?) but in the case of even a shaft coupler, the technical investigator may at any time emerge from obscurity, with a series of experiments, tending to show that present principles of construction are all wrong—bringing fame, indeed, for himself, but only trouble and vexation to the specialiser.

The most obvious cases of one kind of specialisation are those undertakings which deal entirely with appliances for one special pur-

pose, such as laundry machinery, spinning machinery, printing machinery, etc. These are, however, not specialised in the sense in which the word is used in this article. It will be readily seen that this is not productive, but only technical, specialisation. There is, however, in such businesses a fair field for the introduction of a partial productive specialisation in the way of a carefully arranged standardisation of parts. In cotton-spinning machine building this possibility finds its fullest realisation on account of the great number of precisely similar elements, by aggregation of which the machine comes into existence. This kind of specialisation is chiefly of advantage in a commercial sense, inasmuch as the repute of a firm for the technical efficiency of the plant it instals may easily over-rule any mere questions of price. It is not, however, specialisation in the productive sense at all, and must indeed be considered rather to operate in the other direction, by its tendency to allow the field to be ruled by other than considerations of price.

To sum up this brief glance at the conditions under which specialisation progresses: we find that while mechanical limits proper can hardly be considered as entering into the question, so slight must be their influence compared with other ruling factors, the technical and commercial limitations on the other hand are much better defined and recognisable in their influence on possibilities. This influence is not always harmonious; on the contrary, the conditions are very intricate. They may shortly, but very imperfectly, be summed up as follows:

Specialisation in the productive sense will be technically possible when the articles to be produced are already organically simple elements, the technical function of which is well understood and not likely to be modified by local conditions of use. The illustration adopted above, though by no means exhaustive, is a very good one for the purpose—a common shafting coupling.

In some cases some sacrifice of actual conformity to local requirements may be suffered in favour of a standard article, by reason of its price or reputation. A second stage of technical limitation is where a range of appliances for a common purpose allows the engineer to arrange a series of parts or elements common to several or all of the productions. It is evident that this is only productive specialisation by a stretch of the definition.

But this must not be supposed to imply that the article itself must of necessity be of simple construction. On the contrary it may be a complex machine, such as the latest type of turret lathe, a screw-making machine, or a "linotype" machine. Each of these is an organic-

ally simple element. So is a dynamo. But a loom is not. The difference lies in the consideration that the lathe, the screw-making machine, and the dynamo each subserves a number of different ends, according to the organism of which they are ultimately destined to form part. The maker does not require to know this ultimate destination; it is a matter of indifference to him whether the articles are installed in a locomotive works or a South American arsenal. Within their limits they will perform a wide range and serve many ends. The loom will only weave carpets or cloth, as the case may be. Its range is limited to that. That this is not merely an academic distinction may be seen if we consider the first as general, and the second as particular tools. Technically, therefore, the problems limiting the specialisation of the first are much less burdensome than those of the second. It might be better to classify the loom as an independent element, of which the conditions of use are so complex, depending upon the nature of the material to be worked up and the exact class of product desired, as to render a general technical solution of the underlying problems almost impossible, the effect being to limit the scale of production, and to imply the triumph of local conditions over possible uniformity.

Where the technical conditions of the problem favour a uniform product, and hence specialisation, it does not follow that the latter is commercially possible. The visible demand for a certain article may be insufficient to warrant a large outlay. There may be no guarantee that changes of tariff will not unfavourably affect present markets. There may be doubt whether the product will so far commend itself to the tastes of users as to supersede their practice of making it for themselves. There may be a doubt whether the home production is on a sufficiently large scale to withstand the competition of more favoured specialisers working on the basis of a secured home market, whose productions are expected shortly to overflow into this.

That the tendency towards specialisation will have a certain course to run seems certain. But that the final condition of industry will be the existence of a number of separate undertakings, each confining itself to one narrow and special field, is not so certain, although that stage may have to be passed through. It seems thinkable that a contrary current may begin to set in when this stage is fully reached. A process of synthesis or aggregation may ensue, for, other things being equal, it is evident that commercial advantage is on the side of the man who can supply two allied appliances on competitive terms, where his rival can supply only one.

SHOP ARRANGEMENT AS A FACTOR IN EFFICIENCY.

By H. F. L. Orcutt.



GOOD work can be done in bad shops, and bad work can be done in good shops. In these days of high-pressure competition, however, and under the increasing demand for good work, manufacturers must employ every possible facility which reduces the cost of production and assists in maintaining a high standard. Not the least of these facilities is the modernly-designed shop. At no very distant date, the manufacturer who does not possess shops specially-designed and equipped for a particular purpose will be left behind in the commercial race. The steamship, telegraph, and railway are rapidly breaking up trade monopolies which for years have been the main support of antiquated shops. Industries are decentralising and, at the same time, specialising. Only those manufacturers who are the fittest will survive. Those who would erect up-to-date works have now to consider problems never dreamt of by the builders of the majority of existing shops. Model plants are rare in any country, but America leads in respect of numbers, both in regard to what has been done and in the interest taken in the matter of further improvement. It is surprising how many new shops are being erected in Europe with really very little in them that is advanced, and it is still more surprising how many manufacturers are still working in absolute ignorance of the demands of the times concerning the best plans of shops, the selection of equipment, and commercial and social conditions.

The design of a shop, or of works, is mainly affected by the nature of the equipment necessary for turning out the product. Due consideration must also be given to organisation, both commercial and

Mr. Orcutt's articles on Machine-Shop Practice in Europe and America, which appeared in *THE ENGINEERING MAGAZINE*, Jan.-Aug., 1899, will be remembered with keen pleasure by all readers. For comprehensive grasp of the entire subject and instant seizure of the essentials of the best practice, they stood apart as a master-work in the literature of industrial engineering. In this article, in brief outline, Mr. Orcutt applies similar broad views to the solution of the problem of shop design and arrangement. It is a solution which conceives of the shop itself as a great tool that must take its shape and inter-relate all its parts according to the work it is to turn out, and operate as a unit through the perfection of its technical and commercial organisation.—THE EDITORS.

technical, and the time has passed when any manufacturer could afford to erect workshops with little or no regard for that all-important factor, his work people.

In treating the matter under consideration, the term equipment includes all machinery, tools, gauges, auxiliary plant, power plant, means of transportation, and shop fittings. The term technical organisation refers to the arrangement of departments and the positions they occupy; and commercial organisation to a system of keeping track of the progress of work, cost keeping, and accounting. In speaking of accommodation for work people, it is intended to include all appliances, fittings, and details of construction which affect the comfort, health, and contentment of the workers, as well as any systems which educate or instruct. All of the above must be considered by the designer of the modern shop, for the simple reason that all are factors which directly affect the cost and quality of product.

The shop may be considered a huge machine, of which the equipment and men are the moving parts. These are so arranged to work one with the other that the product, passing through, reaches the finished condition with the least expense in the desired state of finish or accuracy.

The functional details are many, and, of course, vary with the nature of the article to be manufactured. Whatever the article is, however, it must be recognised in constructing the modern shop that the specialist has come to stay, and the days of the "Jack of all trades" are numbered. Instead of planning shops in which either locomotives or bicycles can be made, works must be designed which are best suited to the economic production of one class of work. This is a necessity for cheap and good manufacturing, and also conducive to the constant improvement of the article to be produced.

Again, in the engineering world, at least, the era of cheap equipment is passing by. Machines and tools must be selected, and methods of manufacture must be determined upon, which are known to produce the best class of work, all being as far as possible interchangeable. The determination to follow this principle very largely influences the manner in which work must be subdivided, the departments that are necessary, and how they are placed relatively to each other; it also largely affects the selection of auxiliary plant, gauges, and standards. We still have a long and weary pilgrimage to the Mecca of interchangeable work—the pilgrimage started by the mechanic who made the first labour-saving tool. As we go on, however, gradually converting nearly every article of food, shelter, and comfort into the machine-

made product, not only must every machine or part be, of a necessity, of great accuracy, but all operations must be backed up by scientific knowledge, and exact standards must be made use of to take the place of guess work and hand fitting. This is the only method by which the combination of good quality and cheapness can be brought about. Otherwise we must rest content with the cheap and nasty, and only expect the best quality when accompanied by a high price.

How many makers of the marine engine, the loom, spinning machine, bicycle, or locomotive are independent of the "fitter" to give the final "touch" which makes them work, instead of knowing exactly the limits to which parts must be made and then keeping within these limits with the aid of proper standards? How many foundry men know the chemical composition of their cupola mixtures? If some old faithful servant, who has broken pig iron for thirty or forty years, at last retires, whole works are often disorganised with bad castings until a new hand "gets the hang of the thing." How many makers of fine cutting tools know the temperature at which steel oxidises? It is high time that we stopped guessing, and planned to manufacture in our shops with machines which will turn out accurate work, tested by gauges—the limits of which can easily be determined—and that we began to know the chemical and physical properties of all the material used. The skilful workers will then be small in number and their field will be confined to the making and maintaining of plant instead of to producing the article itself; the main body of workers in the modern shop will become little more than machine attendants.

To counteract the evils which may arise from this condition of affairs, the modern shop must provide for the comfort, health, contentment, education, and recreation of its employees. This is an economic necessity as well as a business enterprise. It is curious how little the captains of industry have learnt from the captains of war, yet there are lessons that have been before us for centuries. It is ancient and modern history that the best-equipped, the best-trained, the best-organised, and the best-fed soldiers are the *most efficient*. Manufacturers go on with miserable equipment and no organisation, make no effort to train or educate, and think anyone positively mad who suggests that the matter of food and comfort of employees should receive any consideration. Still, they grumble at the discontent of the worker, his lack of intelligence, the restrictions of trade union, bad workmanship, high wages, and lack of interest in improvement. Whether fighting or working, men are the same; they are assisted by good equipment, improved by good management, made more efficient

by proper surroundings and comforts, and work more intelligently when properly trained. This is neither philanthropy nor socialism; it is business.

Is it more to the profit of the employer to have dirty, ignorant, unhealthy, and discontented than clean, intelligent, able-bodied, and contented workers? Is it more to his interest to erect shops in which everything is ignored that might be desired by intelligent, progressive men, than to have shops so planned and fitted that they will be attractive to only the best class of employees? The most-productive and skilful workers will seek shops which are clean, warm, ventilated, and well lighted, which have the best sanitary arrangements and facilities—which are conducive to comfort and cleanliness—where it is thought worth while to instruct in the best methods of manufacturing and designing, where machines and tools are provided which assist in doing the best grade of work with the least manual exertion, and where a management prevails which not only expects men to be interested in doing good work and in reducing costs, but, in return, shews some interest in cultivating a spirit of suggestion and criticism, and in giving rewards for improvements. Works planned in which the above items were looked upon as worthy of a place in the organisation, would have little to do with the Factory Acts or trade-union restrictions.* I believe 80 per cent. of the so-called labour troubles are due, particularly in Europe, to the fact that so many of the masters build shops and run them absolutely ignoring the comfort, interest, and welfare of the most-important factor of their business—their workmen. Judging by some individual cases which I know, the worst offenders in this respect are those who continually grumble at the shiftlessness and the lack of interest and intelligence in workmen.

Most employers of labour seem to be incapable of comprehending that there is a social question which has a direct effect on the cost of their product. As far as this is concerned Europe is much worse-off than America, on account of peculiar "class" divisions which exist; this disadvantage will continue unless affairs grow worse in America (and there is strong evidence to show that this is becoming the case), or a social revolution takes place in Europe. This point is emphasised for the reason that it is not usually recognised that America has the advantage of working under relatively favourable social conditions.

In planning new works, it is usual to determine first the form, size, outline, and construction of the building or buildings, and then to

* It is highly interesting to see how important a place is assigned, by a clear-sighted observer and practical manager of international experience like Mr. Orcutt, to the labour policy set out in detail by Mr. Patterson, pp. 577-602, this number.—THE EDITORS.

make internal arrangements conform to fixed surroundings. The obviously-reasonable way is to follow exactly the opposite method. Give due consideration to all the requirements of the manufacturing in view, decide on the necessary departments, their areas and relative positions, and let the building assume what form it will, instead of at once settling on having, for instance, a large central aisle and galleries, one or two floors, wings, or what not. The departments of a shop should be broadly considered somewhat as follows:

1. Are any separate parts, like the receiver of a rifle or the hub of a bicycle, to be manufactured in sufficient quantities to warrant putting down complete plants for the production of those parts?
2. Must the parts to be manufactured be made in such small quantities that they would all be put through the same departments?

The majority of engineering establishments must probably follow the latter course. Whatever the arrangement is to be, modern engineering requirements dictate clearly how machine work is to be subdivided, economic production necessitates the specialisation of operations, and transportation gives the cue as to the positions of departments. In calculating areas, it should not be forgotten that floor space for parts in process of manufacture is just as important as floor space for the machinery itself. The designer of a shop who prides himself on crowding machinery into a small space should pocket his vanity and alter his tactics, or perhaps find an appreciative employer in a shop where the management believes in having one foreman in charge of as many men as possible (up to 150, I have known), or in having one man controlling all kinds of machines—lathes, turret machines, planers, millers, grinders, etc.—as well as doing his own inspecting, instances of which are also not unknown to me.

In shops where heavy work is done, it will be found most economical to make distinct divisions of heavy and light work, as totally-different conditions are necessary for cheaply-finishing light and heavy parts. "Stores" form an important factor in modern manufacturing and are a make-shift in all the older works; they should be arranged in three classes:

1. Rough material.
2. Material partly finished.
3. Finished products.

There is at present a healthy recognition of the importance of having auxiliary plant in the way of a well-equipped tool room and a proper equipment of standards, limit and working gauges; this has been a much-neglected item in European shops. The old-fashioned

manufacturer who is still living in the past of hand methods, the "fitter," and primitive machinery, is the last to appreciate this innovation, which is an absolute necessity to the modern shop. I have known many cases where the failure or indifferent success of a labour-saving tool could be traced directly to the absence of a good tool room and the talent which should accompany this important department. Labour-saving machines and tools made to turn out the best class of work at reduced costs, rapidly degenerate unless the means are at hand for constantly regenerating. The accurate lathe, the universal milling machine, the universal grinding machine, the shaper, and the cutter grinder are as necessary to the modern plant as the forge and grindstone were to the old-fashioned shops, where the greater part of the work was performed on simple machines, aided by hand tools. Tool stores with up-to-date small tools and gauges should not be forgotten. If the shop is large enough, it will be found advantageous to provide for these stores in the several departments. The selection of tools and gauges must not be made in a too-niggardly spirit; many European manufacturers have yet to learn that tools are of as much importance as machines. The success of labour-saving accurate machines is largely dependent on working them in connection with properly-made tools and fixtures, and in keeping these adjuncts in the best working condition. In many shops there is little or no provision for storing and distributing tools and fixtures.

The thread which knits the whole fabric together is the system of transportation of parts. Too often in designing new works this part of a modern equipment is left to work out as best it may, when in reality it should be studied from the beginning. The building should be planned so that systems could be installed by which labour is reduced to a minimum and every minute of time saved. I should think few works can afford to neglect to consider the very complete system of light-railway appliances which are now obtainable. Fast-running electric cranes and pneumatic hoists seem to be the most-efficient means of handling parts which cannot be lifted by hand. The principal items concerning the structural features of the works are the design of floors, ceiling for overhead rigging, heating and sanitary arrangements, and windows. Each item is worth considerable attention, as all affect the economy of manufacture. It has been my intention to mention only those points which it seems should be considered by those who would erect really modern works, in which every thing should be embodied which aids in economical production. Details of equipment and organisation have been purposely avoided.

APPLICATIONS OF ELECTRIC POWER IN ENGINEERING WORKS.

By Louis Bell.



THE electric motor at the present time does not have to formulate a reason for its existence in connection with engineering works in order to prove its adaptability to the mechanical problems that there have to be solved in so many and intricate ways. The motor has taken its place as one of the every-day, hard-working, steady-going, reliable pieces of apparatus that is to be counted on and used with the same freedom that a pulley or a block and tackle would be applied in its appropriate place in the constitution of a modern industrial plant. The question now is not whether the electric motor is a sound and conservative method of furnishing power, but whether it is particularly adapted to the purpose in hand. If it is so adapted, its use needs no explanation; if not, some other solution of the particular problem attacked must be sought. In this respect the situation as regards electric motive power has developed itself in a highly satisfactory manner during the last few years. Those who were in the electrical art near the time of its beginning remember well the anxious eyes that were cast on the early electric motors—how the pros and cons of the queer, new apparatus were discussed industriously and how, for years, motors were looked upon somewhat askance, as allied to things not altogether comprehensible and possibly of ill repute. All this is changed and now the manager of the modern works, in the organization of the tremendous industrial mechanism which he has under his hand, depends on engines or water

Dr. Bell's most interesting paper, beyond its direct value, affords striking evidence of the existence of Industrial Engineering as an exact science, having fixed principia accepted by all its professors. Thus in his treatment of the adaptation of electrical drives and the use of portable tools, he displays the idea developed by Mr. Orcutt—(pp. 717-722) that the whole works should be regarded as a single great tool, of which separate machines are the moving parts: in his reference to the tendencies of intensified production, he harmonises with Prof. Higgins (pp. 568-576); in his reference to the uses of electrical appliances to increase the workman's comfort, he endorses the position taken by Mr. Patterson (pp. 577-602) and Mr. Orcutt.

Dr. Bell rightly dignifies the part electricity has played in the economy of modern productive engineering. It is peculiarly his field. THE ENGINEERING MAGAZINE has in preparation similar reviews of the kindred services rendered by the sister-agencies in the application of mechanical power—Compressed Air and Hydraulic Methods.—THE EDITORS.

wheels or compressed air or electricity, as the particular occasion and the particular work require.

As a rule, the general uses of electric motive power in such operations are in one of the following four directions:

First:—To secure by the utilization of transmitted power a cheaper motive power than could be secured from a localized power plant, either steam or electric.

Second:—To distribute motive power, from whatever source obtained, more economically than it can be distributed through mechanical means.

Third:—To take advantage of the singular mobility which electrical-power distribution permits, in order to utilize to the fullest the portable machine tools of various sorts which are now coming into extensive use.

Fourth:—To adapt the well-known art of electric traction to the oftentimes onerous task of transportation within the works.

To these may be added a few instances of electric current used as current for certain specific purposes not connected with motors.

The first count is something apart from the immediate purpose of this paper, the advantages of power transmission having no particular relation to the general problem of the utilization of electric power in modern industries. Such transmitted power may be, and has been many times, utilized with great success and with a very gratifying degree of economy. In fact, one of the earliest power-transmission plants at high voltage, now in operation for seven or eight years, was in the great industrial works of Escher, Wyss & Co., near Zürich, Switzerland, where three-phase current at 14,000 volts has been the main motive power of the works for the period just mentioned.

The second form of utilization of electrical energy is, however, one of great importance in many directions. For all large industrial purposes there is a great and usually somewhat erratic demand for power, both in the various departments of any given works and, from time to time, in each department. A great manufacturing establishment does not ordinarily run under the conditions of load which may obtain, for instance, in cotton-mill work, where most of the machinery is in use all the time and the demand for power is singularly steady from minute to minute as well as from day to day. The philosophical basis of the economy of electric power under such conditions lies in the fact that where power is distributed by purely mechanical means over a considerable area, the losses in transmission are practically independent of the load, and hence at light loads, either on particular machines

or in particular departments, these losses are relatively and necessarily severe. In electrical distribution the losses in transmission are proportional to the load, and being at all times less than the losses in the mechanical transmission over any reasonable area, are particularly slight at times of light load, so that the average economy of distribution is sufficiently high.

It is well-known—too well-known to admit of doubt or be a proper subject for discussion here—that the total efficiency of an electric-distribution system, from the brake horse power of the prime mover to the power delivered at the shafts of the motors, usually ranges from 75 to 80 per cent. at full load, and should not under ordinary circumstances fall off more than say 5 per cent. at one-third to one-half load.

Now, inasmuch as the average losses in the shafting in miscellaneous shops for metal and wood working are usually between 30 and 50 per cent., and sometimes more, the character and amount of the saving to be obtained by the application of motors becomes sufficiently obvious. In an establishment taking, for example, one thousand horse power in miscellaneous machine work, the losses on average load in the distribution by shafting from the single prime mover would rarely be found to be less than 50 per cent. The average loss with the electrical distribution would very seldom be found to be over 30 per cent. This means a clear margin of 20 per cent. in the saving of power—200 horse power out of every 1,000; at \$50 per horse power per year (which is not an excessive estimate on the cost of 10-hour or 12-hour power obtained from steam under such conditions) the saving would amount on this basis to not less than \$10,000 per year—an economy which promptly and vigorously speaks for itself. The saving in this amount is less than would be found in many cases which have come under my notice, and could be trusted to pay for the installation of the electrical plant in a comparatively short time.

In point of fact, it is safe to say that in the transmission of so large an amount of power as that just mentioned from a single prime mover, the losses in shafting and belting would be considerably in excess of those just given, and the saving in an electric drive would be correspondingly larger. As a matter of practice, it usually happens where the aggregate power is so considerable that a single prime mover is discarded in favor of several or many engines, placed in various parts of the works and each adapted in size to its particular purpose. This substitution too often "changes the place but keeps the pain." A 1,000-horse-power engine can be operated, as is well-known, at vastly better economy than twenty 50-horse-power engines; the

former will operate on 15 to 25 pounds of steam per horse-power hour where the latter will require from 30 to 50 pounds. It is not particularly advantageous, except in the item of wear and tear on shafting, to substitute a loss in the engine cylinder for a loss in the shafting, since the coal pile suffers about equally in each instance.

In certain types of small engines often used in practice the steam economy is very much worse even than that just mentioned. Tests made within the last few years on the auxiliary machinery of war-ships have shown some startling examples of inefficiency. Tests, for example, made on the cruiser *Minneapolis* showed that the average consumption of steam per indicated-horse-power hour in the auxiliary engines was nearly 120 pounds, while even the best of these engines showed a consumption of 70 to 75 pounds per indicated-horse-power hour. Similar results have been obtained on numerous recent war-ships, both in the United States and elsewhere. Of course these conditions would not often be found in a manufacturing works, although there are few large establishments employing numerous engines in which such conditions would not apply to some of the engines installed. Steam pumps, when used, are particular sinners against economy, often taking from 100 to 300 pounds of steam per horse-power hour; so notorious has this fact become that even in large electric stations it is often found advantageous, purely from the standpoint of economy, to use motor-driven pumps, taking current from the main generators, rather than to pipe steam even a few feet and use it in the steam pump. Wherever it is possible to use electric motors coupled directly to individual machines, the power consumption required for mechanical operations can be diminished in a very remarkable degree. Of course, in cases of very small individual machines so much is lost in the efficiency of the motors that a group drive—a single motor operating a number of smaller machines—is more economical than the use of separate motors; but in the larger classes of machine tools, such as are continually in use in all large engineering works, direct-connected motors, causing no waste of power nor any running expense when not actually needed, are each year coming into more extensive use and are steadily raising the average efficiency of motor installations.

Fig. 1 is a type of recent practice in this respect, and consists of a $7\frac{1}{2}$ -horse-power motor geared directly to a very large milling machine. The actual power used in cutting away metal by a tool is not generally large compared with the total power taken to operate the gears through which the machine functions, and this loss in the direct-

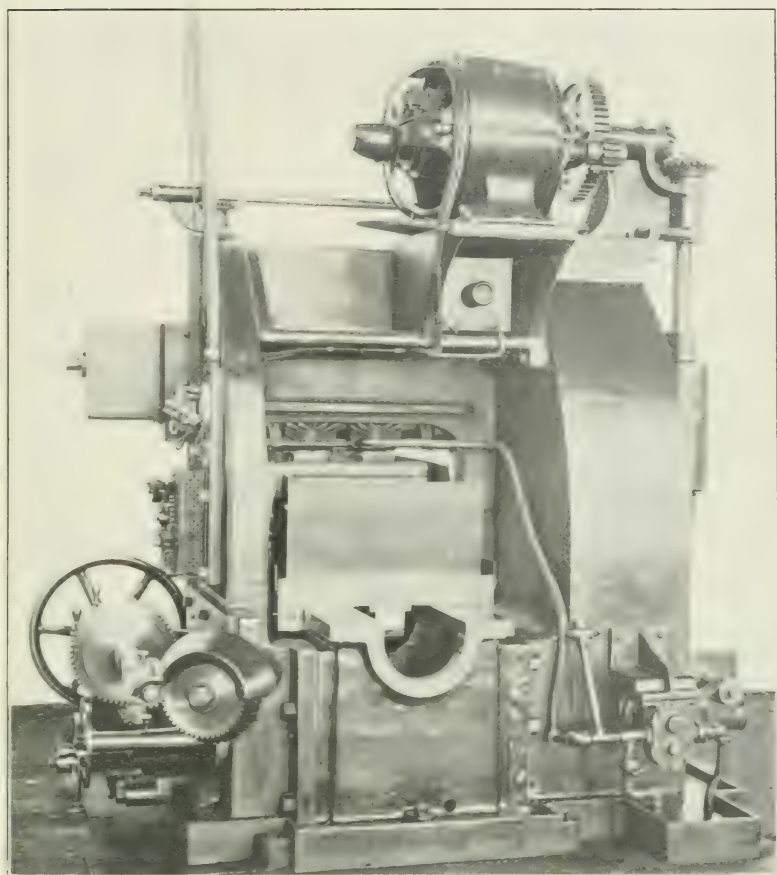


FIG. 1. LARGE MILLING MACHINE DRIVEN BY DIRECT-CONNECTED 5-HORSE-POWER GENERAL ELECTRIC MOTOR.

coupled milling machine is the only material loss and is cut off while the machine is stopped, while in ordinary practice, where such a milling machine is driven by such a shaft actuated by a loose pulley and belt shifter, the shafting loss (likely to be as large as the whole useful power employed in the machine) goes on whether the machine is in full operation or not. Fig. 2 is another excellent example of a large direct-driven machine, being a squaring shear for heavy plates driven by a 5-horse-power motor. Here the momentary work is considerable, but the average work on the machine is not great and, again, all the power used is limited to the machine itself and not wasted on the transmitting shafting. Fig. 3 is a similar machine on yet larger scale.

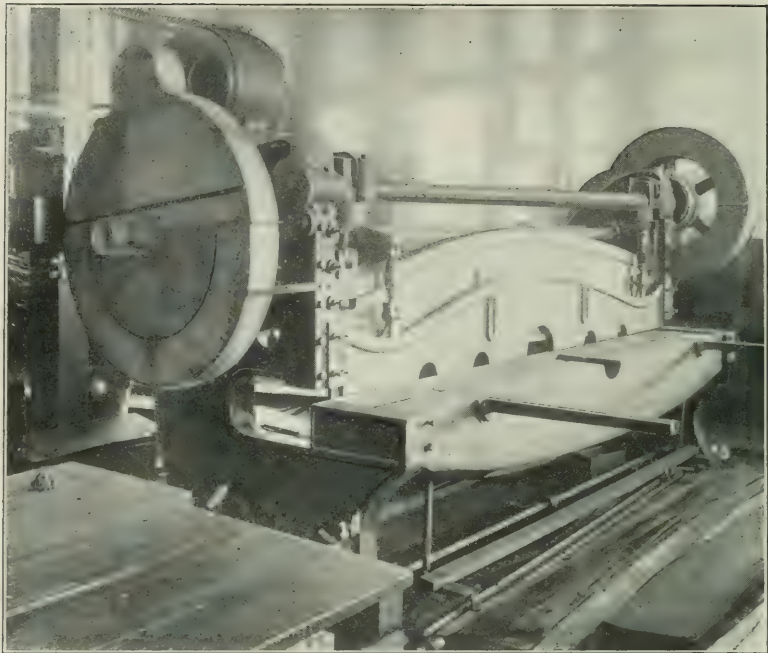


FIG. 2. SQUARING SHEARS FOR STEEL PLATES, OPERATED BY 5-HORSE-POWER ELECTRIC MOTOR.

General Electric Company.

while Fig. 5 shows practice of a more usual kind, in the use of motor-driven punch presses.

Fig. 4 is a good example of similar methods applied to wood-working machinery, being a 5-horse-power motor directly-connected to a planing machine. In machines of this class, owing to the high speed of the motors, considerable power is required even when running light, and yet, under ordinary conditions of shafting, the energy wasted in transmission is still a considerable portion of the power required at full load. Data on a machine of this type may not be uninteresting and may be tabulated, briefly, as follows:

Planer, running light.....	2,400 watts
Spruce plank, 12 inches wide, feed 23 feet per minute, maximum power	6,500 watts
Average power.....	3,400 watts
Minimum power.....	2,475 watts

This loss is substantially the friction load.

Pine plank, 12 inches wide, feed 39 feet per minute, maximum power	7,200 watts
Average power.....	4,518 watts
Minimum power.....	3,225 watts

This probably represents an unusually favorable case in large machine work, the power actually consumed in doing useful work being at its maximum nearly three times the friction load. If the truth were known, it would be found that an efficiency of nearly 75 per cent., in a machine working even under the most favorable conditions, is very much higher than is usually found in large machine tools as they are worked day by day in actual practice.

The advantages in electrical driving, thus far indicated, have been merely those with respect to distribution of power—in other words, actual saving in the cost of motive power for the establishment; as a rule, however, such savings are smaller than those which can be made by a deft adaptation of electrical drives. In shops where very heavy work is done, careful managers are driven to the use of portable tools, since, in numerous instances, the tool is very much more portable than the object to be worked. In dealing with heavy castings and punch-

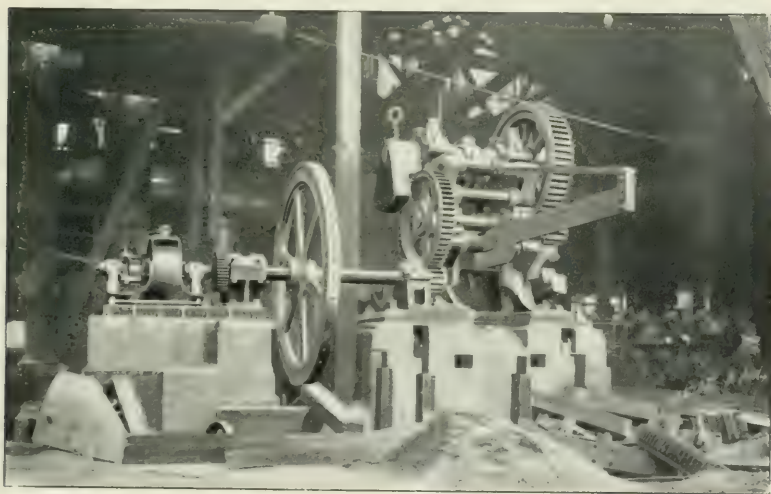


FIG. 3. ELECTRIC-DRIVEN CUTTING-OFF SHEARS, WORKS OF THE SHOENBERGER STEEL CO., PITTSBURG, PA.

Westinghouse Electric & Manufacturing Co.

ings, it is much more convenient to keep the work stationary and move the power than it is to adopt the reverse process, and for this a very large variety of portable drills and milling machines have been devised and put into use. Here again the advantage is one of convenience, of facilitating the necessarily slow progress of heavy work through the shops, and of enabling one process after another to be carried on while keeping the work stationary.

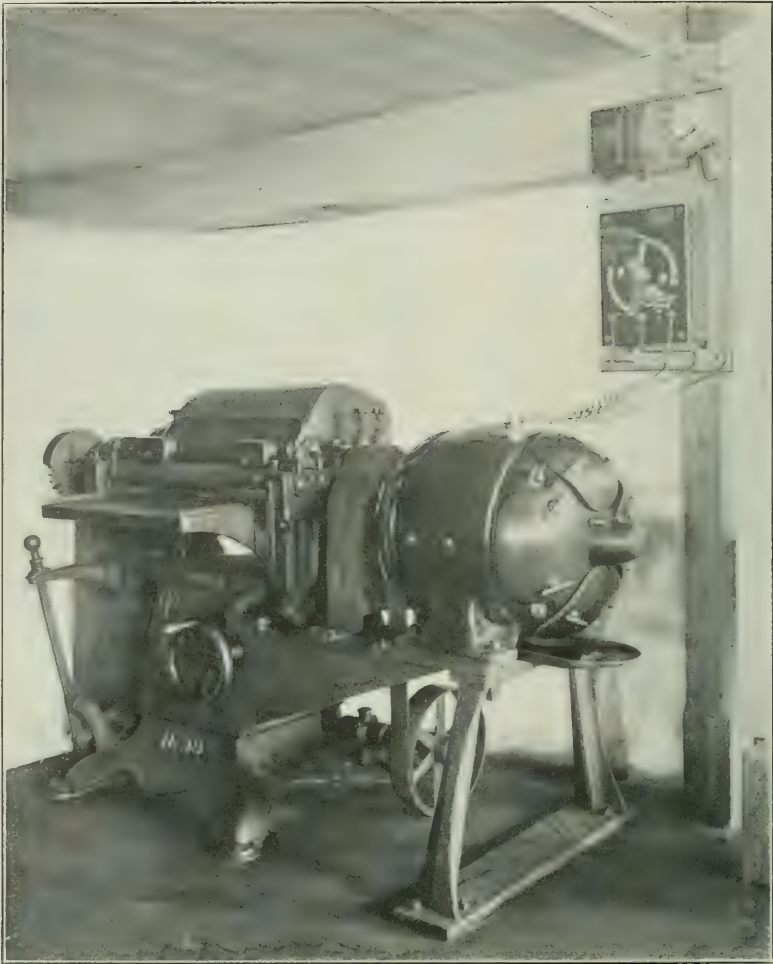


FIG. 4. ELECTRIC-DRIVEN PLANING MACHINE OPERATED BY 5-HORSE POWER MOTOR.
General Electric Company.

Fig. 6 is a good typical instance of this sort of practice, now become tolerably familiar. It is a 2-horse-power motor driving a portable drilling outfit from a flexible shaft; the convenience of an apparatus of this kind needs no comment, and a considerable number of similar machines are at work, not only in the various engineering works, but in the Government navy yards, where they are found enormously convenient for executing repairs, as well as for facilitating structural work generally.

Speaking broadly, anything which facilitates the mechanical oper-

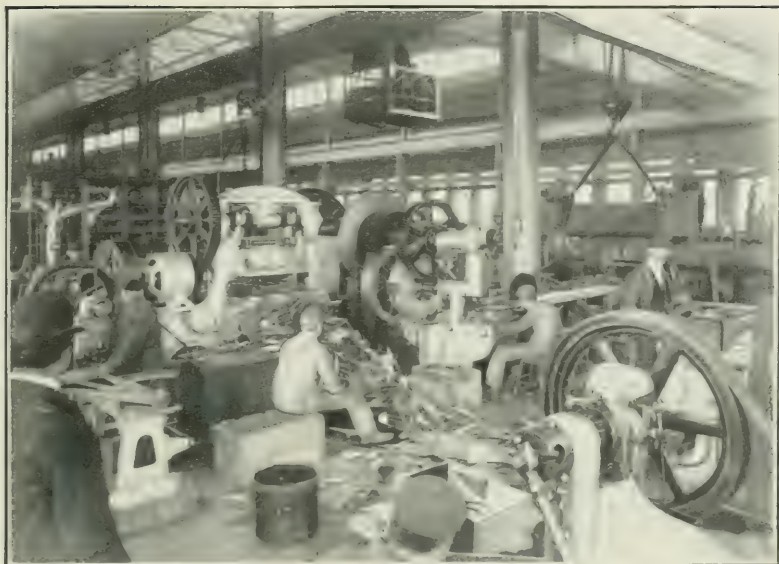


FIG. 5 PUNCHING DEPARTMENT OF THE BULLOCK ELECTRIC COMPANY'S WORKS, CINCINNATI, OHIO, OPERATED THROUGHOUT BY DIRECT-CONNECTED MOTORS.

ations which have to be performed cheapens production. In the average manufacturing establishment it is not power that is the chief advantage of concern, nor material, but labor. Especially is this true in American establishments, where the relatively high prices paid for labor make economy especially necessary and where the relatively in-

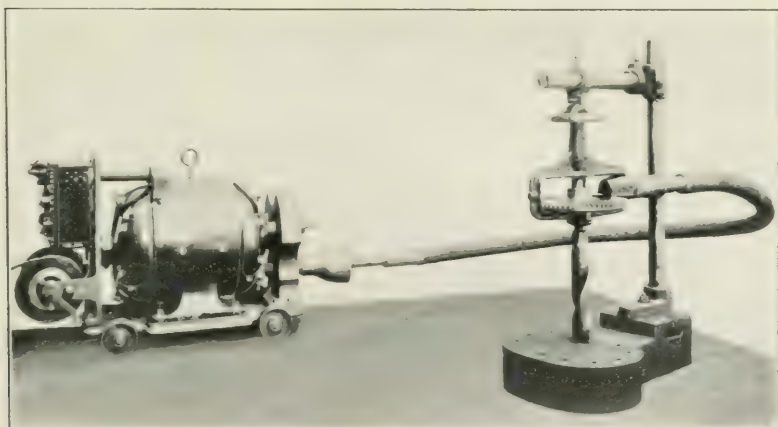


FIG. 6 A PORTABLE DRILL DRIVEN THROUGH FLEXIBLE SHAFT BY 2-HORSE-POWER MOTOR.

General Electric Company.

telligent character of the labor makes labor-saving appliances possible. In the organization of a manufacturing industry, the finest opportunity for finesse on the part of the manager lies right here in the adaptation of his machine outfit to quick and ready work in turning out his product. A manufactory has an efficiency just as truly as a single machine. The more the product which can be turned out of an individual machine in a complete and efficient state in a given time, the higher the economic efficiency. This fact does not appear so clearly in a general manufactory as it does in some special lines in the industrial arts. The extreme importance of economizing the labor by labor-saving devices and of keeping all the machines going at full capacity all the time has come to be a part of the regular system of manufacturing, but in many works it is sadly neglected. The free use of portable tools economizes both in manual labor directly and also in the transportation expenses, which are no small item in many industries. Where the work invariably has to go to the machine, and where the machine cannot come to the work, the whole product has to move through the factory in a steady procession; if anything gets out of line, it either blocks the road for something else or is itself passed by and comes in late, to the intense disgust of everybody concerned. Engineering works are not like print cloth mills: they do not turn out a uniform product year in and year out, but make a very wide variety of things, differing not only in magnitude but in kind. This happens to be particularly true in electrical industries, with which I am especially familiar.

A large electrical-engineering works manufactures regularly, as part of its ordinary output, things differing as widely in size and character as wooden spoons, rat traps, and locomotives. Now for the efficient performance of the industrial machine, it is highly important that the wooden spoons, rat traps, and locomotives should be kept apart and not shuffled up together through any mistake in routine, and it is just here that electrically-driven tools come to the rescue; the tools can go the round of the work in a more or less regular procession, completing each single task in definite order, and their steady operation is only interfered with while the tool, and not the less mobile work, is being shifted. Along with such applications of electricity come the infinite variety of smaller applications which simply serve to facilitate the work of the men who are the connecting links in the industrial mechanism. Cranes and hoists and tramways all have their place in hastening the final end of getting the work through the shop promptly and effectively, without putting a single man's labor for an

hour in any place where it will not actually count in the quantity or quality of the efficient product.

An electrically-driven shop is singularly free from obstructions of any kind, and thereby is rendered easier to work in. Fig. 7, a motor-driven tool shop, shows how the complete abolition of shafting and belts clears things up and frees the space of encumbrances.



FIG. 7. AN ELECTRIC DRIVEN MACHINE SHOP, SHOWING THE CLEAR HEAD ROOM AND LIGHT AFFORDED BY THE SYSTEM.

Tool shop of the Bullock Electric Company, Cincinnati, Ohio.

In the category of electrical appliances which facilitate labor come such apparently trivial things as lights, fans, and blowers. I remember watching with amusement, a few years since, the course of operation in an electrical establishment where field spools were being wound. A long line of men were pounding steadily away at their tasks on a hot summer afternoon; one of them, midway the line, being of an inventive turn, had clamped to the countershaft in front of him four huge palm-leaf fans, which whirled steadily around for his exclusive benefit; the cheerful inventor stuck steadily to his task, winding away with the utmost placidity, while his neighbors on either side were stopping to mop the perspiration from their foreheads and growling to each other about the extreme heat. That one man saw his opportunity and will be a walking delegate some day—if he is not one already. Even such little things—in other words, looking out for

the comfort of the workmen by bettering the light and bettering the ventilation—tell in the ultimate output. It is not so much what each individual man is paid as it is what work he does that determines the economic efficiency of manufacture.

In all large establishments the transportation problem becomes serious, and there has been a steady increase during the past few years in electric tramways winding in and out of the shops and across the yards, to facilitate the distribution of raw material and the transportation of partly completed or finished product. The economic value of such tramways is at the present time obvious enough; they can be used in a particularly efficient way because, in any given factory, the general progress of material is a thing which can be to a certain extent predetermined so that the tramways can be put where they will do the most good, and the net result is the substitution of mechanical labor for hand labor, which in all except certain skilled trades has been proved an advantage a thousand times over. It is a saving of the same general type as that found by using a telephone system to connect the manager's office with the various departments. Three-quarters of the work of informal communication is now done by telephone, and the astute manager simply extends the process and transports his material as well as his wishes electrically.

For general purposes, no motive power has proved itself quite so convenient as electricity; there are certain types of tools, percussive tools in particular, which are operated to great advantage by compressed air, and certain types of lifts actuated by compressed air have proven immensely convenient. As a whole, however, the method lacks adaptability, and while we have heard continually of the vast advances which were to be made in the use of compressed air for general purposes, most of these have not as yet materialized. A volume might now be written on minor applications of electricity in the manufacturing arts, but the subject is one which can scarcely be treated in a single brief paper. Electric heating, welding, forging, and annealing all have their place in certain engineering works, and all are in successful operation for particular purposes. Every few months some new wrinkle in these minor uses comes to the front, occasionally rising to considerable importance, like handling steel plates and billets by traveling magnets, a fine example of which practice is shown in Fig. 8; many of them, however, simply amount to local adaptations for the solution of some particular problem, but one never knows when they may develop to a startling extent, even as the electric furnace has developed in the past few years.

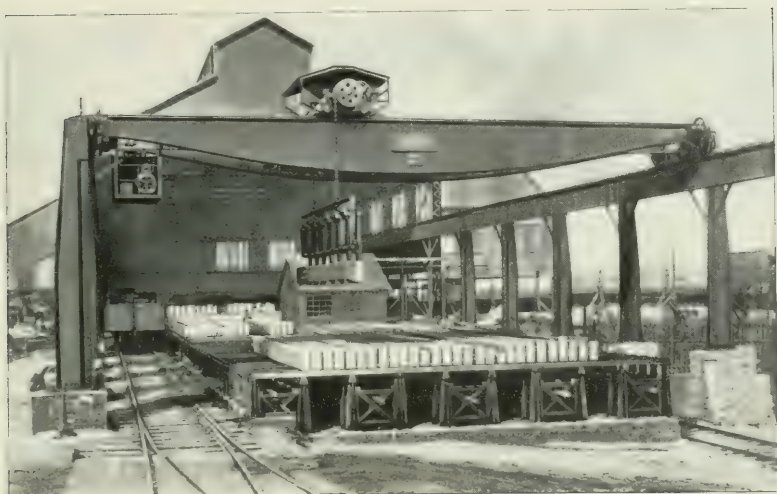
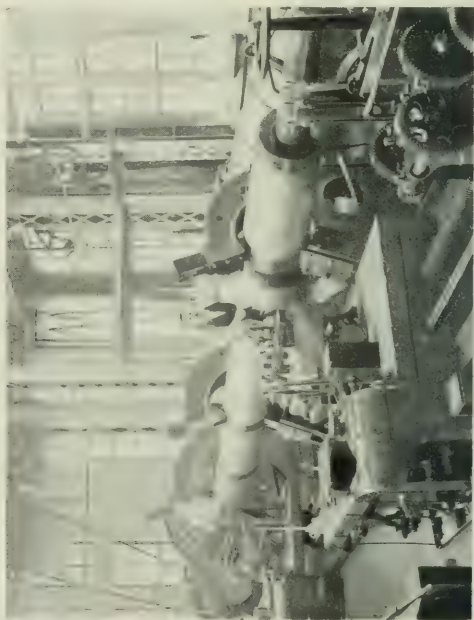
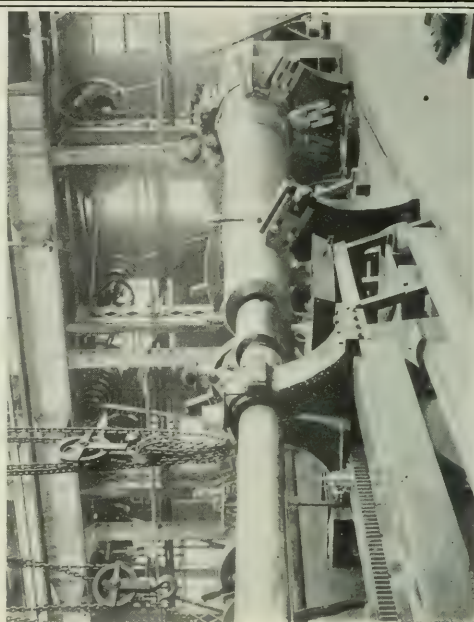
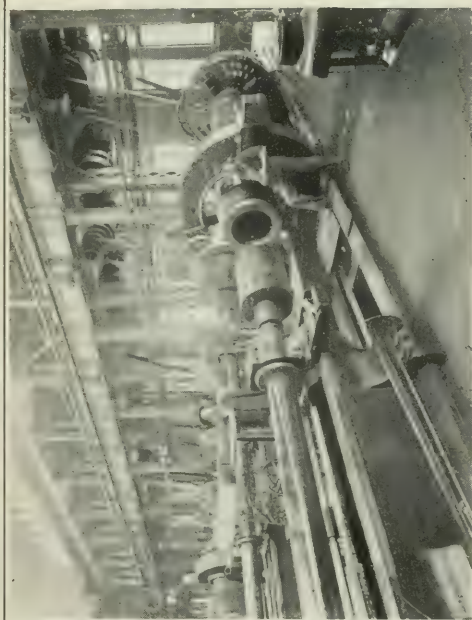


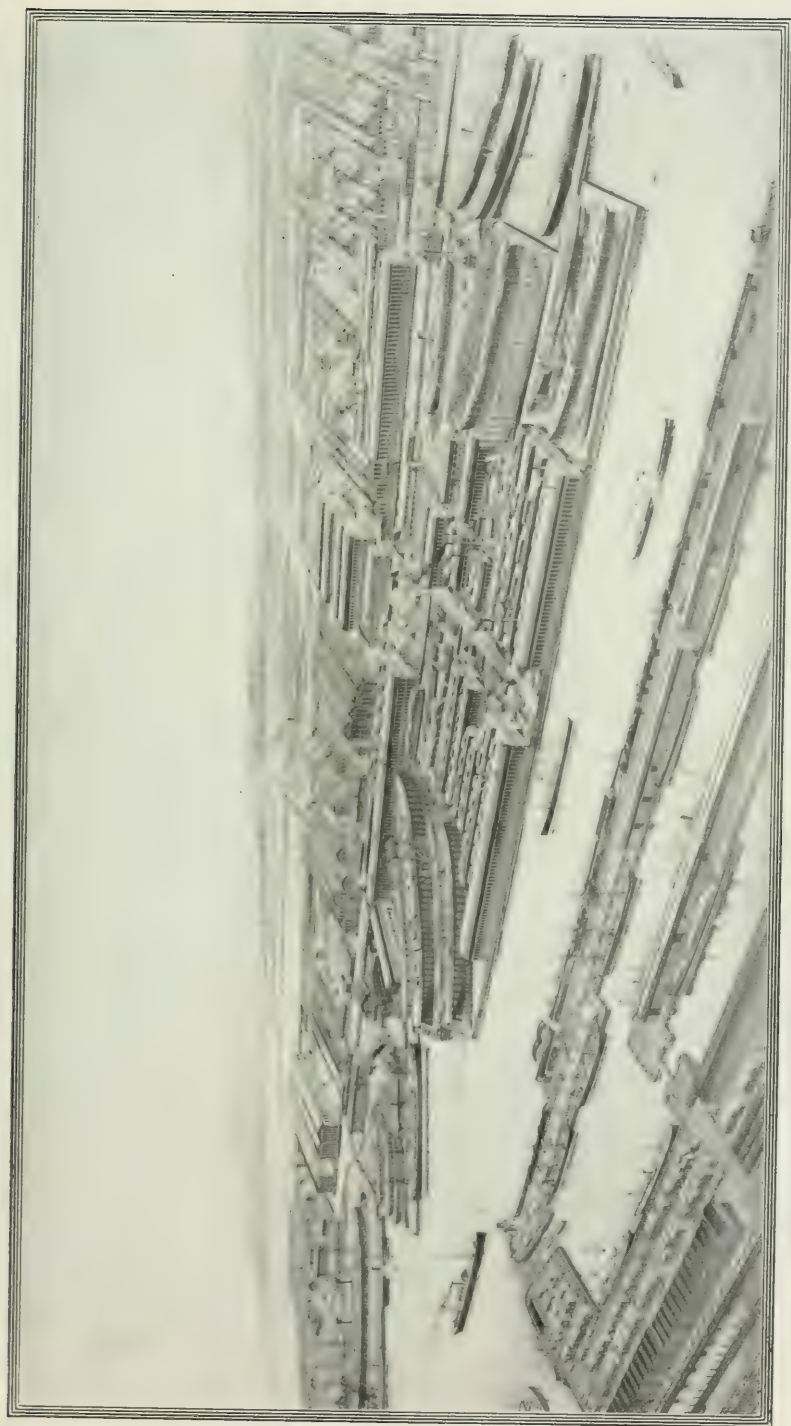
FIG. 8. — ELECTRIC CRANE WITH LIFTING MAGNETS, NATIONAL STEEL COMPANY'S OHIO STEEL WORKS, YOUNGSTOWN, OHIO.

Each establishment has problems of its own to solve, and it is the task of the engineer to treat these problems systematically. To use electricity or compressed air where it will facilitate particular kinds of work, and to use a more direct mechanical process where the one now in use is intricate, leads to advantage; the main facts to be borne in mind by the manager of any industrial establishment with relation to such questions are these: First, that electric motive power and electrical methods have already proved their usefulness in many ways, some of these ways being such as will readily be adapted to problems that rise in almost any class of manufacturing. Second, that the most important single thing in administration is keeping down the total labor cost, and the trend of modern practice, based on sound experience, with relation to this particular economy, is towards reducing this cost—not by employing lower grades of labor or paying the workmen less, but by arranging the conditions of labor so that the work is done in a vastly more efficient way. American supremacy in the engineering arts has been gained through tact in the adoption of labor-saving devices. In the achievements of the Yankees in these particulars electricity has taken no small part heretofore. With the development in the past decade in electrical methods and apparatus, their application is likely to be of greater economic value in the future than it is now, or than the most enthusiastic partisan of electrical methods ten years ago would have cared to stake his reputation by predicting.



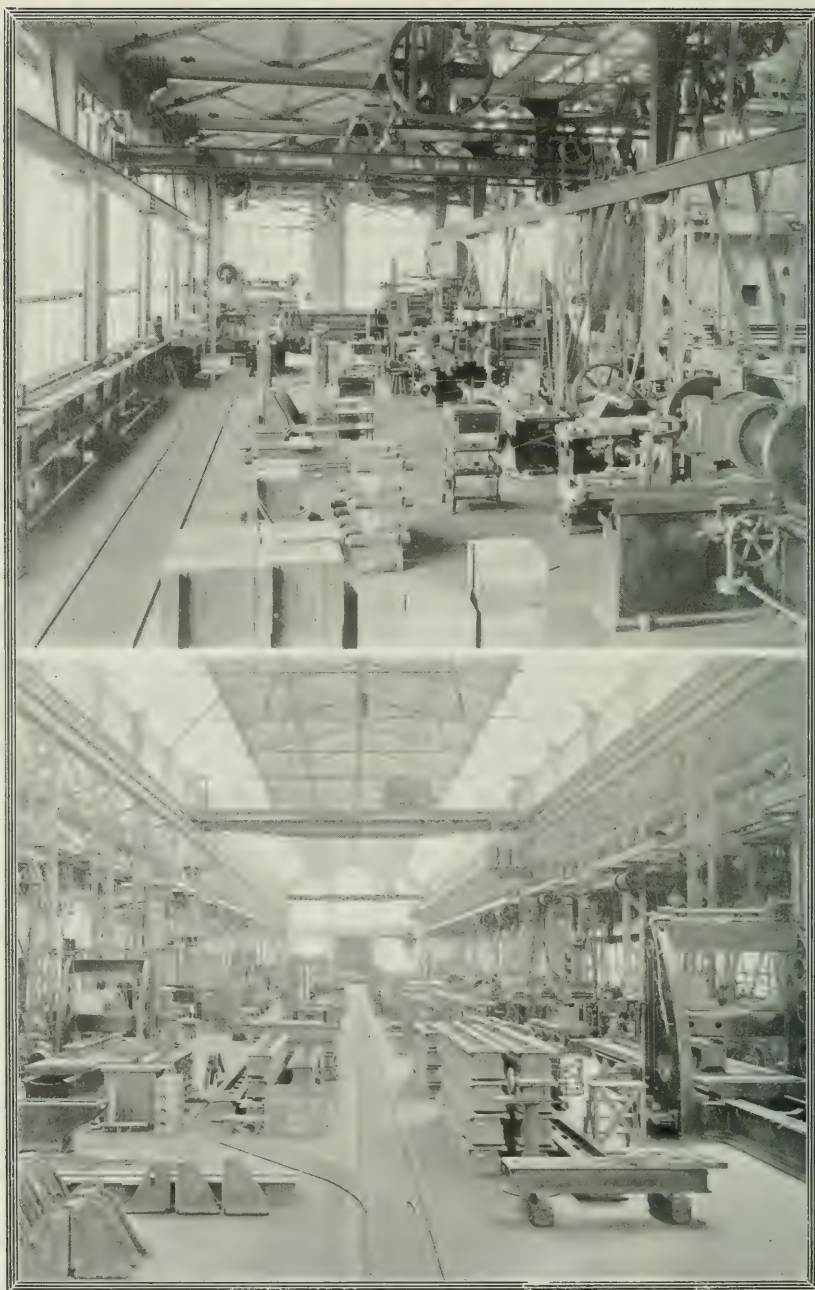
OPERATIONS IN THE MACHINE SHOPS OF THE UNITED STATES ARSENAL, WASHINGTON, D. C., U. S. A.

The units handled are of the heaviest class, the engravings showing various operations in the making of a 13-inch gun, which is 40 feet in length, 4 feet in diameter, and weighs, unmounted, 145,000 lbs. The upper left-hand cut shows a row of heavy lathes; beside it is the rifling bar; below it is the operation of boring a 13-inch gun tube; the lower right corner shows the cutting of the rifling grooves.



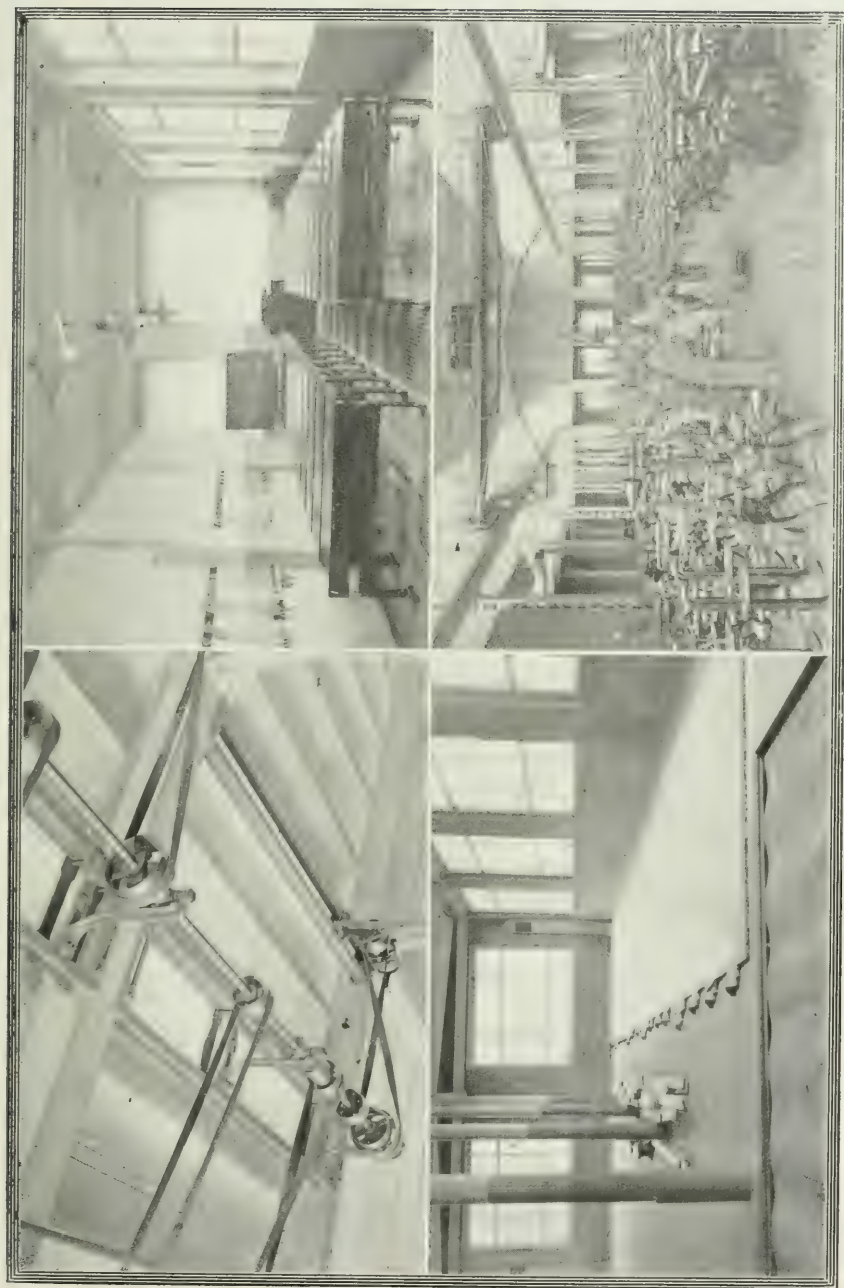
GENERAL VIEW OF MESSRS. HARLAND & WOLFF'S SHIP-BUILDING AND ENGINEERING WORKS, BELFAST, IRELAND.

At these yards were built the White Star fleet, including the *Oceanic*, the largest vessel afloat, exceeding in size the *Great Eastern*. Many interesting appliances were devised for the construction of this ship, among them the great gantry crane seen about the middle of the picture.



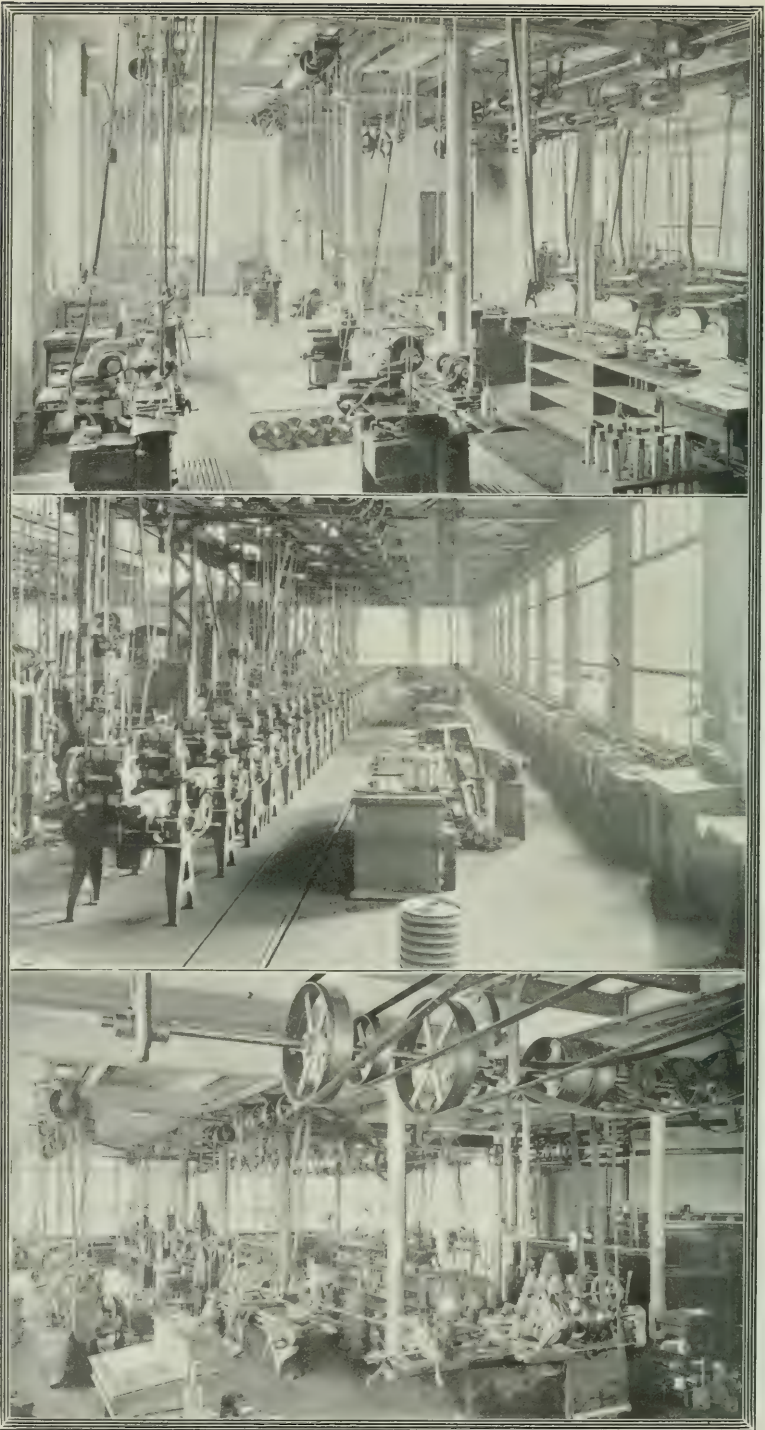
HEAVY-WORK DEPARTMENTS IN THE MACHINE SHOPS OF LUDWIG LOEWE & CO.,
BERLIN, GERMANY.

The works are designed, built, and operated throughout upon plans determined after exhaustive study of the best models of Europe and America. American practice predominates. The upper view shows the heavy milling department, the lower one the main machine hall for heavy work and erecting.



VIEWS IN THE LUDWIG LOEWE MACHINE TOOL WORKS, SHOWING CHARACTERISTIC FEATURES.

On the left is shown above the method of clamping counter shafts and hangers to shop ceilings; below, is shown how the shop floors are laid the top of hard maple, and the surface everywhere true. On the right, the upper picture is the school room for apprentices, where instruction is given free on the company's time; below is the machinery store house in the "Administration Building."

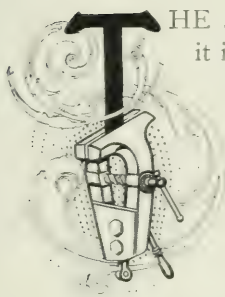


THREE DEPARTMENTS IN THE LUDWIG LOEWE SHOPS.

Top, grinding department—very largely used; middle, erecting floor for light machine tools; bottom, chucking department.

THE RADICAL POLICY OF SCRAPPING COSTLY MACHINERY.

By H. F. J. Porter.



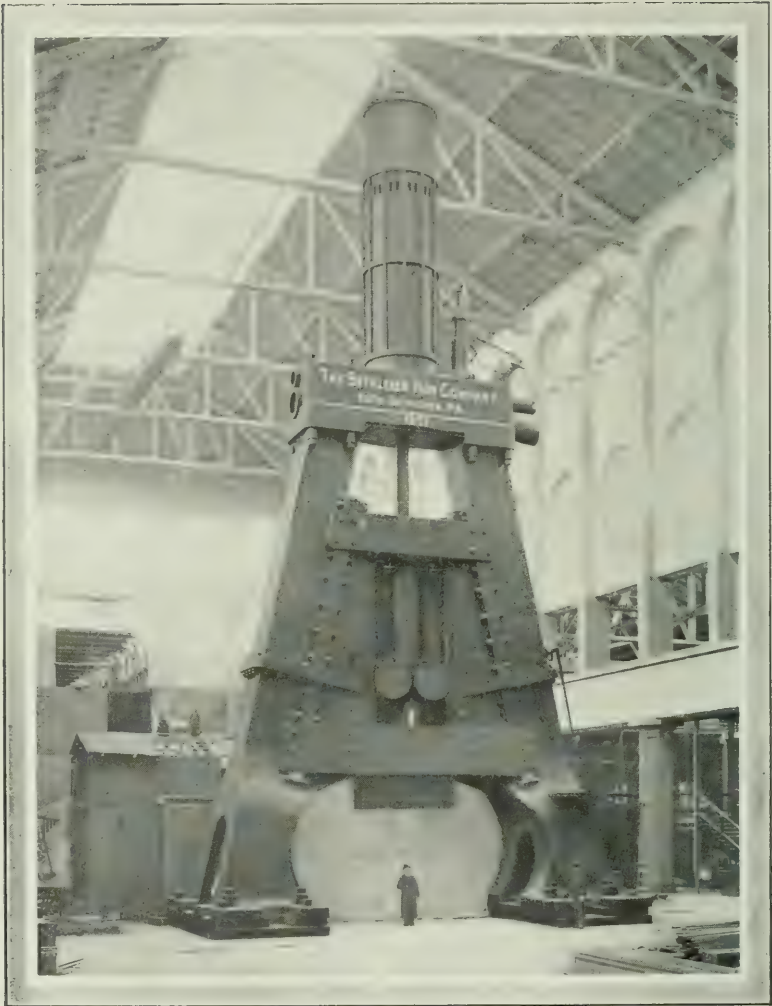
THE statement has been made by those whose province it is to analyze statistics that every year chronicles an advance in progress greater than was achieved by the previous two.

It is not our purpose now to discuss whether or not such a ratio can be sustained by proof, but what we are here concerned to note is the fact that the rate of advance which industrial and commercial development has attained during the last third of the present century has been far more rapid than that which characterized its movement during the first two-thirds. In fact, the change in the curve of progress is so pronounced at the beginning of the period first mentioned that it is impossible not to comment on the fact and to draw the deduction that at this point some occurrence of momentous import took place.

When we revert our mental vision down through the vista of the past, crowded as it is with countless happenings of vast importance, it is not difficult to discern the time referred to, nor to be impressed with the fact that the condition of affairs which then obtained was altogether unprecedented. Looking as far back as the line bisecting the century we find the times buried in empiricism. Men groped about in the dark, depending upon repeated trial and failure to find the way. Progress, led by error, halted from discouragement.

In 1862 the Land Grant Act was passed and the Technical School came into existence. The last third of the century began with only four of these schools in operation, but, though primitive in the extreme, their effect was being felt. The spirit of prejudice is most persistent where knowledge is most wanting, and in those days the inventions of men were ridiculed and looked upon with

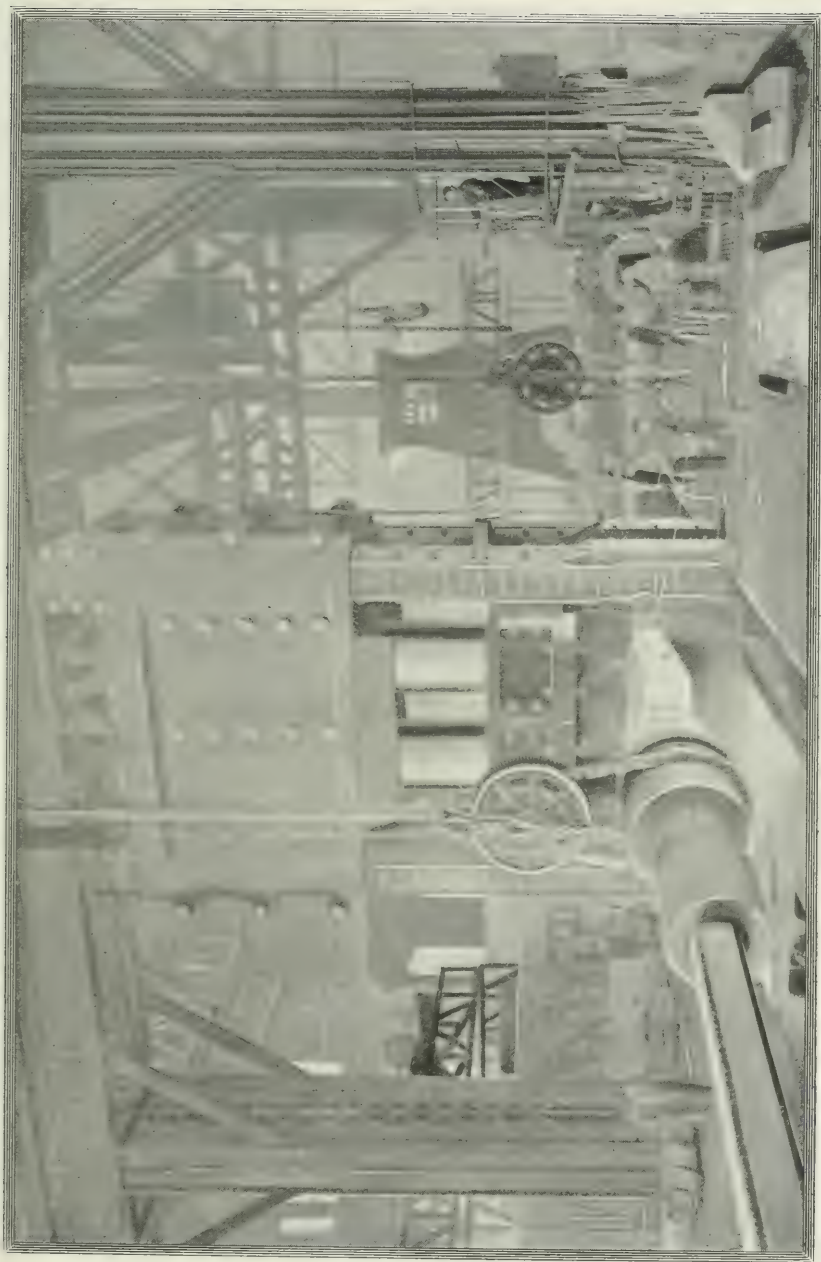
The practice which has come to be generally recognised as "American" has no more startling feature than the one here discussed by Mr. Porter—the instant discarding of any appliance, however costly, however sound it may still be, when a better is obtainable. To its critics it seems to be thinly disguised iconoclasm. To its adherents it appears the foremost element of success. It can be rightly judged only in the large—can be known only by its ripened fruits. And foremost among these stand such examples as the Carnegie and the Bethlehem steel works. To an authority intimately connected with the latter of these great enterprises is fitly committed the triumphant exposition of the overwhelming strength of the policy.—THE EDITORS.



125-TON STEAM HAMMER, SCRAPPED BY BETHLEHEM STEEL CO. IN FAVOR OF THE 14,000-TON HYDRAULIC FORGING PRESS SHOWN ON THE OPPOSITE PAGE.

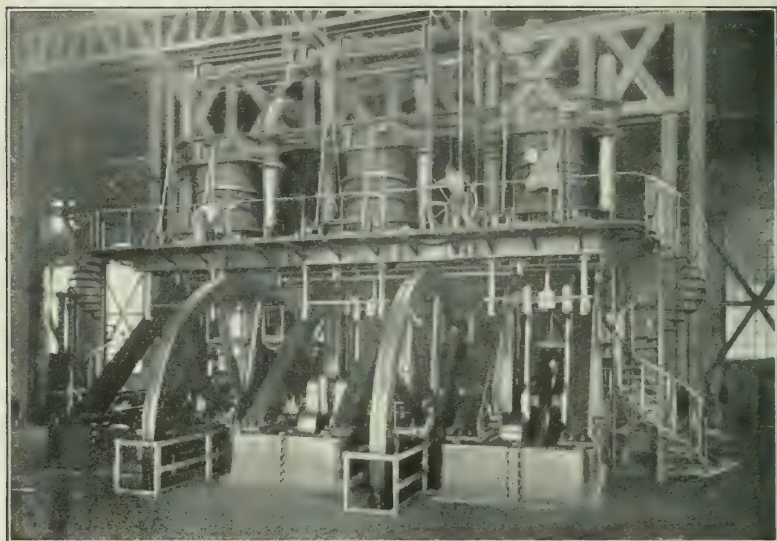
This enormous tool—the largest hammer ever built—had scarcely begun its expected career of usefulness when it was superseded by a more efficient appliance. The view is taken from the full-size model exhibited at the World's Fair at Chicago, 1893.

suspicion. Only the most rugged characters were strong enough to overcome the trammels that hampered them. Among such men were two whose great and originaive minds and undaunted courage and persistence developed at this time the Bessemer process of making steel, of which it has been said that, with its introduction and the



THE 14,000-TON HYDRAULIC FORGING PRESS, SUCCESSOR TO THE 125-TON STEAM HAMMER, AT THE BETHLEHEM STEEL WORKS.
The partly dismantled hammer may be seen in the background, waiting the time when the demand for the space it occupies will lead to its complete dismemberment, and the melting furnace will convert its component parts into some other and more modern appliances.

growth of other processes springing from it, have come about a higher state of development and a greater advance in civilization than were caused by all previous inventions of man put together.



15,000-HORSE-POWER ENGINE AND PUMPS SERVING THE 14,000-TON HYDRAULIC FORGING PRESS, BETHLEHEM STEEL WORKS.

The majestic proportions of the press are suggested by the size of this individual power plant—as great as that of a large ocean liner.

But the wonderful impetus to industrial enterprise due to this discovery would not have obtained its strength had it not been for the influence of the technical institutions of learning, which opportunely at this time began to come into existence. For, as the arts could not be successful until the abstract sciences became exact, so also the latter were of no avail until they were made use of and incorporated in the industrial arts. As these institutions became operative, correct methods of reasoning, based on scientific knowledge of the principles of causation and sequence, were applied. The natural inclination of similarly educated minds to come together for interchange of thought brought about the technical society, where the effects of the application of scientific methods upon the forces of nature were discussed. Finally, when these discussions were widely disseminated by means of the latest and broadest educator, the technical press, then at last dormant minds awoke, latent thoughts were expressed in action, and misdirected energies were correctly applied.

In these early days industrial undertakings were not of great magnitude and methods of organization and management were necessarily crude, but concentration of attack by correct methods brought about unprecedented development in all lines of industry; opportunities for mental and bodily activity were presented on every side and enterprises grew in dimensions and increased in number. Strenuous effort to increase and improve product and to reduce cost in the severe competition that arose brought about rapid and great improvements in mechanical appliances. In some industries so great were the inducements offered to inventive genius for suggestions leading to economy and efficiency that improved machines were scarcely installed before others vastly superior were in the market to supplant them.

In fact, an instance is on record of an enterprising manufacturer, who, desiring to be foremost in his industry, had equipped his shops with what was considered the best machinery, but found himself in a few months behind his laggard competitors who had, by waiting, become possessed of a superior type of mechanism.

A case of this kind calls for but one method of handling, if the policy of keeping in advance is to be preserved: viz., to replace the recently purchased machines, all of which may be in perfectly good condition, by the newer equipment, or by that having a still higher efficiency, if such is obtainable. What then is to become of the discarded machines? The only market for them would seem to be among one's competitors, and yet they, if progressive, ought not to want them. Hence, as they will, in all probability, never be used again, their only value is as junk, and their relegation to the scrap heap is inevitable. That comparatively new, and in many cases costly, machinery can be deprived of its value by no accident to itself, and before its normal term of service has expired, is a fact that is well known to many men, both inside and out of manufacturing pursuits. There are, however, an equal number of men similarly occupied to whom such a possibility is beyond comprehension, and into whose estimates of deterioration of plant it does not enter at all.

Changes such as this are expensive, not only in immediate outlay for purchase, but in the lack of co-operation on the part of those on whom dependence must be placed to make the purchase a practical success. The substitution of new machinery for old may be of two kinds, and the enthusiasm of the operatives who are directly interested in any particular case will be minus or plus accordingly. In one kind the new machinery will seriously reduce the number of operatives, or, by the simplicity of its automatic features, will render skilled attend-

ants unnecessary, thereby reducing wages. Here at once a condition is confronted which makes the problem complex. It would, indeed, be an unusual type of humanity that would voluntarily and with any degree of enthusiasm aid in the erection of his own gallows. But there is another kind of substitution, where the machinery to be replaced may be merely larger or stronger, for the purpose of increasing the size of each piece of finished output; or the new may be such a modification of the old as would be necessitated by a change in design or shape of product. If fashion decrees a modification of type to suit its whim, the manufacturer must recognize and meet it at whatever cost. Such a change does not generally affect the number of operatives, or their wages, other than possibly to increase either or both at least temporarily. Beyond the incidental delays involved in adapting themselves to the manipulation of machinery that is unfamiliar to them, no particular discouragement on the part of the operatives may be anticipated.

It cannot, of course, be said that all the changes under discussion fall by a hard and fast rule into either one or other of the above divisions. Conditions vary, so that individual cases may fall partly in one and partly in the other category, and the situation is made more serious or ameliorated, depending upon whether complications of the first or second kind predominate. By far the largest number of sweeping changes in the machinery of manufacturing plants have been of the second kind. They may, in fact, be compared with the changes that are constantly taking place in the road-bed and rolling stock of all our railroads. Light rails are replaced by heavier ones; bridges which are perfectly sound give place to others of stronger construction. Cars and locomotives, although in good condition, are disposed of and others of heavier build and greater capacity replace them. A most notable instance of this type was the Niagara Suspension Bridge, which, erected in 1853-55, at an expense of about \$400,000, was replaced by a stronger structure, of cantilever type, in 1897, at a cost of approximately \$315,000.

Changes such as these take place in consequence of the increasing demands of industrial development, which, by its tendency towards concentration, calls for the transportation of larger and heavier machinery and for bulkier cargoes of coal and food supply. In times of great industrial growth, advance is most rapid in those lines which supply the demands of that development, and radical measures must often be taken in individual manufacturing establishments, in order that they may be able to keep up with the growing demand.

As we look back through the last third of the present century, glancing at those industries which have made most rapid strides in progress, many conspicuous instances of this practice of scrapping expensive machinery are noticeable. Of all the many enterprises, those which have been associated with and closely related to the iron and steel industry have had the most phenomenal growth. From among these we will first draw a few examples.

Up to 1857 iron-rolling mills were crude affairs, with trains of two-high rolls and reversing engines. In that year the Cambria Iron Company, of Johnstown, Pa., intending to overhaul their rail-mill, called upon their superintendent, Mr. John Fritz, for a design. Mr. Fritz submitted one for a three-high roll-train, which, after considerable persuasion on his part, was accepted. The mill was built and run, and turned out rails successfully, but only after bitter opposition on the part of the operatives. The men went on strike and burned down the mill, but it was rebuilt, and by the time it was in operation the three-high train of rolls was an assured success. The foremost mills throughout the country at once scrapped their old two-high trains and substituted for them the later and more efficient machinery. The original two-high mill at the Pencoyd Iron Works, Pencoyd, Pa., after running eighteen years, was at this time replaced by a larger three-high mill, with a new engine and entire equipment, complete. This mill, after running twelve years, was also scrapped, on account of the advent of the Bessemer process and the change of product from iron to steel.

The old "crocodile squeezer," used to expel the slag from puddled iron balls, was in use in all iron mills up to 1840, when the rotary or so-called "coffee mill" squeezer was invented by Henry Burden, introduced by him at his iron works at Troy, N. Y., and afterwards put on the market. The adoption of this mechanism was also at first attended by much opposition on the part of the employees, owing to its automatic features and the tendency to dispense with skilled labor, but this very efficiency made its adoption insistent, so that, notwithstanding the fierce appellation of its predecessor, it replaced it in a few years and was the cause of its utter extinction by scrapping.

Generally speaking, this practice has been adhered to as a business policy in the representative rolling mills of the United States, such as the Carnegie Steel Company, the Illinois Steel Company, the Pencoyd Iron Works, etc. In the plants of these concerns whole mills have suffered scrapping, in a manner similar to the fate of the two-high roll train, whenever a number of improvements were offered,

which, if applied to the old mill, would have practically amounted to its rebuilding.

Fifteen years ago the last mentioned company built a 20-inch three-high structural mill driven by a 32-inch by 48-inch vertical engine. This mill was considered by the engineering world a model of its kind. After running ten years, however, so many improved mills had been built at other plants that it was considered out of date. After attempting to introduce new tables and manipulators for handling material, and to otherwise modernize it, the whole mill, engine and all, went into the scrap heap, and in its place was erected an entirely new mill for turning out exactly the same product, viz., structural material, but, of course, to much greater advantage.

Improvements in furnace design have invariably led to the scrapping of the old, with a constant tendency towards increase in the size of the new. As these metallurgical appliances are constructed entirely of brick, it is easier and cheaper to tear them down and cart them to the dump than to attempt to modify them. A noted example of this was given by the Midvale Steel Company, of Nicetown, Pa., which, in 1874, changed its method of melting steel from the crucible to the Siemens-Martin process as being better suited for its product of tires, axles, etc. A fine row of crucible furnaces, etc., was destroyed and on its site an open-hearth plant of latest type erected.

The Bethlehem Iron Company, South Bethlehem, Pa., in 1890 erected the largest steam-hammer ever built, having a capacity of 125 tons falling weight. This was operated successfully for three years in the manufacture of armor-plate, but when, in 1893, a new type of this product was invented by H. A. Harvey, it was found that the hydraulic press was better adapted to its manufacture, and this enormous tool, which, with all its accessories, cost in round figures a quarter of a million dollars, was immediately set aside, to be replaced at a similar cost by a hydraulic press, which to-day still remains the largest in the world. This is probably the most notable instance on record, on account of the great expense involved, of the substitution of a more efficient tool for another, the normal life of which had only just begun. In this instance the hammer was not scrapped, in the hope that some day its use might be revived, but has stood in a partly dismantled state for seven years, the probabilities now being that, as the hydraulic press has entirely superseded it, when the natural expansion of the works demands the ground it occupies it will find its way to the melting furnace.

In 1897, Krupp having perfected a new type of armor-plate, part of

the furnace plant previously used in the manufacture of Harveyized plate at South Bethlehem was torn down, and furnaces of a new design, with a gas-generating plant, were erected in their stead, resulting in a vastly more efficient product. Now a Krupp plate 6 inches in thickness will resist impact where previously a 10½-inch plate was required.

Also, in 1899, while experimenting to establish a standard grade of tool steel for use in the machine shops, two engineers employed by the company, Messrs. F. W. Taylor and Maunsel White, discovered that a special treatment applied to a steel of peculiar composition would impart to it a property of resisting fusion at very high temperature. Application of the use of this steel has been made to cutting tools, where its power to resist the heat due to the friction of cutting enables it to work at from twice to three times the speed of the best tool steel in the market. The adoption of this steel throughout the shops at once necessitated great changes in shop methods. Counter-shafts running at 90 revolutions were speeded up to 250 revolutions, and provision was made for enabling individual machines to be still further speeded up. This increase in speed has raised the number of pounds of metal cut per tool per hour from 30 to more than 150. Naturally, an increase of machine output of 500 per cent. was not accomplished without considerable expense, from modifications made necessary by the changed conditions of working. More than 50 tons of old cutting tools were disposed of in the market for what they would bring. Subsequently this new tool steel and treatment process were put on the market and shop rights sold to representative concerns in America, and European rights are being disposed of, the English rights having already been obtained by Vickers Sons & Maxim. There is no doubt but that the speeds obtained by this treated tool steel will eventually become standard. Their adoption will be slow, as all healthful growths should be, but when accomplished there will have been brought about a complete revolution in machine design and in machine-shop practice and a scrapping of hundreds of tons of less-efficient tool steel.

The great combinations of capital which have taken place during the past two years have united into one harmonious entity the efforts of separate and competing manufacturing establishments.

In the course of reorganization many of these plants have been found to be not as modern in equipment as others, or are less advantageously located. In the focalization of effort at central points, the tendency towards which practice we are constantly encountering, many

of these plants have been dismantled and their contents sold on the spot for junk, not being deemed worth the cost of transportation; and yet, until the fever for combination swept across the land, the firms which operated these same plants were satisfied with their condition and looked forward to many years of prosperity in the use of the equipment then employed.

The development of electricity has been a potent factor in bringing about in all industries the substitution of machines operated by that force which were previously run by air, steam, or water. The ability thus afforded to concentrate the generating power plant into one central station, from which power for all purposes could be developed and transmitted to great distances by mere wires, enabled great economy to be attained by substituting traveling cranes, lifts, elevators, and various other appliances individually driven by electricity for those otherwise controlled. In many of these cases, however, the machinery displaced, except when it was of special design, has been disposed of to others for what it would bring, instead of being annihilated.

On all sides may now be seen examples of the change of motive power on street railways, from the horse and cable propulsion to electricity. In 1890 the central station of the Boston Street Railway was designed and built, the company intending to equip it with electric generators of larger size than any previously contemplated. After carefully considering the requirements of the plant it was determined to drive these generators by belts, previous experience in this direction fully warranting the following of precedent. Considerable delay occurred in the furnishing of these generators, and smaller ones were temporarily loaned to take their place. Meanwhile, in one of the other stations of the road, some direct-connected generators were installed and an opportunity was thus afforded to compare their efficiency with those that were belt-connected. The difference was so plainly in favor of the direct-connected type that, as there had in the meanwhile developed a need for additional power, steps were immediately taken to change the central station to a direct-connected plant. The belted generators were taken out and the engines equipped with new shafts, pillow-blocks, and flywheels, and new direct-coupled generators. By this means more floor space was obtained and the capacity of the station was about doubled, with very little additional cost for operation. Here it must be noted, however, that not all of the machinery was scrapped; only the shafts, pillow blocks, and flywheels suffered that fate, the generators being sold for about one-fourth the original cost.

In this case the alternative would have been the purchase of a new

site, and the erection of a new building, with complete equipment. By making the change as outlined an undoubted saving was accomplished in total outlay, the returns from the sale of substituted machines and scrapped material aiding in materially reducing it.

We are at the present time viewing the struggle between the southern States and New England for the final home of the cotton mill. The proximity of the raw material and the unlimited supply of cheap child labor in the South at present favor that locality, and threaten the long-established and enormous mills of the East. In the growth of this industry competition has been most severe, and the introduction of labor-saving machinery has been accompanied by long and serious strikes. The experience of the largest cotton mill in the world, the Amoskeag Manufacturing Company, at Manchester, N. H., may in its struggle for supremacy be considered representative. Here recently have been consigned to the shears several hundred "top flat" cards that were doing just as good work as the "revolving flat" cards which replaced them, but by the change more work at less cost could be obtained from the same floor space. Several hundred looms which were making good cloth have been broken up to make way for others that replace an empty filling bobbin with a full one without stopping, thus enabling a weaver to attend more looms. A thousand Scotch looms, whose normal life would have been 20 years, and which were imported at a cost of \$100,000, were scrapped after 10 years' service to be replaced by others of American design which make practically the same goods at less cost.

So it has gone, and so it still goes, with those enterprises which are to survive in the struggle for existence. Concerns may be compared to human beings, the management being likened to the mind, the equipment to the body. They have their youth, their prime of life and their old age, and finally they die. According as the management is active and keeps itself informed, or settles comfortably down, relying for success on its reputation or the peculiar environment which brought it into existence, will depend its health and whether it will stand a giant of its race or die a weakling.

The more rapidly changes take place in industrial conditions the more readily must the policy of management be adapted to meet them. Never was competition more severe, and never have more concerns of old standing and tried reputation gone to the wall or been absorbed by younger ones than at the present time. And the reason is that their management has not kept itself informed and followed the methods of younger and more active enterprises. An intuition of expediency,

born of a broad experience, is a possession essential to successful management.

Harmony between the management and the operating force is essential, and the antagonism engendered by the feeling that the management looks upon its employees as a necessary evil must be obliterated. In the introduction of modern equipment and modern methods the lack of co-operation on the part of the operatives is the most serious source of trouble. It must be evident to the veriest tyro in the science of management that to keep abreast of the severe competition of the day the paternalistic methods of the first two-thirds of the century must give way to the individualism which dominates modern policy. It is only rational to suppose that new methods and appliances will be taken up more readily by those who are educated and encouraged to be efficient than by the survivors of a harsh and degrading despotism.

Huxley says, "There are two opposing methods at work in the government of the world—respectively the ethical and the cosmic." The practice of that which is ethically best involves a course of conduct which in all respects is opposed to that which leads to success in the cosmic struggle for existence. In place of thrusting aside or treading down all opposition, it requires that the individual shall not merely respect, but shall help his fellows. Its influence is therefore directed not so much to the survival of the fittest, but to the fitting of as many as possible to survive. By no other scheme of management can any enterprise hope to keep in the front than by that in which ethical principles have been strongly indoctrinated.

Experts in the science of shop management are doing great good to humanity by preaching practical religion, for they are teaching business men that "it pays" to introduce into their works methods and appliances which will uplift their fellow men. Technical schools of the first order have already admitted to their forums lecturers on this subject, but the institution that first includes in its curriculum courses in manufacturing and social engineering will send forth into a public field a host of workers who will garner a rich harvest. For the more enlightened the type of man employed, the better will be his work and the higher will be the standing of the firm that depends upon the result of his labor for its success. Among such men methods can be introduced which will stimulate them not only to exert their maximum of effort in the minimum of time, but to offer suggestions toward improvements in methods and appliances. Such methods will soon bring about a condition of affairs where the relegation of a comparatively new tool to the scrap heap, when another of greater efficiency has been devised, will be the most ordinary procedure.



THE DISCIPLINE AND CONTROL OF RAILWAY EMPLOYEES.

By W. H. Canniff.

IN considering the relations of the railway to its employees every thinking person will at once recognize the vast complications which the problem presents. Not only is it necessary to provide for prompt handling of merchandise under every conceivable condition, but such provisions must be made as will insure the safety and comfort of thousands of passengers who use the roads, as well as those of the men employed.

Again, the railway company is known to the communities through which its lines pass only in the persons of its accredited agents, and upon their tact and general bearing must largely depend the esteem in which the company is held, resulting in coöperation or antagonistic relations as the case may be. Not only does this apply to commercial relations, but also to such police regulations as look to the clearing of streets and similar requirements on a long line of railway. How to

Mr. Canniff's article on "The Relation of the Railway to its Employees," first written in 1895 and published in *THE ENGINEERING MAGAZINE* for March of that year, has ever since stood as a classic in the literature of railway-labour management, unapproached by anything else written on the topic. The six years intervening have brought its author great advance—largely increased responsibilities—ample scope to test to the uttermost the principles enunciated. And in response to the request that he restate his views for the far wider audience reached by this international issue of the Magazine, he writes: "I have most carefully gone over the article in detail, reaching only one conclusion, viz., I have nothing to add, no change to suggest. It represented my views then—it does now. I am more clearly convinced than ever before that the principles enunciated in this article, if applied to either large or small corporations, will bring good results." Mr. Canniff's review stands, therefore, as the formulation of a policy so surely founded on bottom principles that it has stood the trial of daily application, in every aspect of labour matters and general economic conditions, throughout the whole range of relations found in a great organisation, and has never failed nor needed readjustment.—THE EDITORS.

insure this desired result is one of the most perplexing problems which confront a manager.

It is manifest that good and sufficient discipline is a prime factor, of which, to my mind, absolute justice is the foundation principle; and on this basis can the obligation of a railroad company to its employees and to the public be best carried out. It is obvious that, whatever the rules and regulations, their execution depends upon a large number of men surrounded and largely influenced by varying conditions. This being true, it follows that, in the formation of all rules governing the operation of a railway, great care should be exercised to see that they are based on correct principles, neglecting no feature which experience has shown to be necessary in an intelligent execution of such rules, and taking into account the various phases which affect human nature as a whole, remembering that those who are to execute the rules are a part and parcel of the human family.

At this point, however, the work has just begun. While to the mind of an intelligent officer the rules or instructions are clear and explicit, he should bear in mind that their execution depends largely upon an equally intelligent comprehending and understanding by those who are to carry them into effect.

When it is realized that an author usually devotes chapters to definition in order to convey exact ideas, it will be admitted that to give correct expression to ideas much thought and study are required, and that those who are to receive the idea must understand the language used for its conveyance. Hence the great necessity for intelligent direction is apparent.

Men who do not have a fairly intelligent idea of what may be termed the general fitness of things are very low down in the scale. Much more plainly than their employers imagine do they see the relation of the order, or instructions, to the work to be done. The nature of their work makes them keen observers in most instances, quick to recognize in the instructions even the slightest defects, or mistakes, or the want of application to the work in hand, which cannot fail to weaken their respect for those who issue them; and, while the mistake may be easily corrected, the effect upon the men remains.

They have the same hopes and fears, aspirations and desires, as other men, and are surely deserving of every consideration when the importance of their work is remembered. That the employee will do more efficient work if his interest and coöperation are secured cannot be controverted, for the evidence is at hand in every walk of life. When fairly balanced, the interests of the railway company are identi-

cal with those of the employee, for with good discipline and highly efficient labor the comfort and safety of the public is conserved, the investment is made profitable, and good wages can be maintained. How can this desideratum be achieved?

First: by most painstaking care in the preparation and promulgation of rules and instructions.

Second: by clearly conveying to the employee what is desired, it being his right to know what is expected of him under all circumstances.

Third: by having him understand that the rules are such that, if intelligently executed, they will insure his own well-being, as well as that of the company, and that compliance with them will result in recognition, either in the way of commendation or promotion.

Fourth: by strict attention to matters of discipline, never permitting employees to be suspended or dismissed except for good and sufficient cause—this to be shown by clearest proof of violation of rules that were fully understood, and such violation to be invariably disciplined, without waiting for the evil consequences which such rules were intended to avoid.

Fifth: by a consistent course of action which will impress upon the employee the fact that it is the earnest purpose of the company to render him exact justice in every instance.

Men entrusted with the care and responsibility of handling a large body of employees widely scattered over an extended territory must have exceptional talent in order to secure the best results. They must fully understand how vast the interests are which are committed to their care, and upon their fidelity and wise direction the welfare of many employees and their families depends.

The first proposition—that great care should be exercised in the preparation of rules and instructions—is certainly of vast importance, owing to the fact that these are, of necessity, the foundation upon which the whole structure is to rest. They must be such as practice and experience have approved. For illustration, in the preparation and adoption of a schedule, affecting, as it does, during its existence, the movement of every train or engine, there is most valuable information to be gained by consulting those employees whose duties bring them in daily contact with the service performed. Thus not only does the management get the benefit of the employee's experience, but the employee is encouraged to study more closely the problems which arise in the service, with a full knowledge that his ideas will receive the consideration they deserve.

Again, much stress must be laid upon the second proposition. Not only must the foundation of the rules or instructions be clear and conclusive to their author, but the rules must be so worded as to convey to the employee the desired meaning; and to this end the employee should be encouraged to make it known promptly if there is anything in his instructions which he does not fully and clearly understand, thus giving him incentive to comprehend better, and confidence to ask for necessary explanation.

The third proposition calls for such wording of the rules as will adequately explain their purpose. Where for various reasons they cannot be so worded, a duty may devolve upon the management to explain the reasons for issuing them. It will be said that this is impracticable, but I do not deem it so. If a well-disciplined and highly efficient corps of men is desired, additional duties will be forced upon the management, as well as upon the men. To give the men a logical understanding of the rules is not as difficult as it may appear, and the advantage to be gained in the moral effect upon the minds of those who are to execute more than compensates, in my opinion, for the additional care and labor. It obliges the maker of the rule to exercise greater care in its preparation, in order to defend it when questions arise, and leaves the employee no possible excuse for failing to carry out its provisions.

In considering the fourth proposition, we come to what may properly be termed the most vital point of all.

To write an order, or issue instructions, is a simple matter. To secure the desired result is quite another matter; and, even when care has been exercised, and the instructions are based on good and sufficient reasons, a proper execution is difficult to attain.

The science of good government has occupied the minds of able men for centuries, and various methods are proposed in governmental affairs. Legislation in many instances is followed by failure through neglect of the underlying principle that governs all human action—*viz.*, that man must be held to strict accountability for his actions, in whatever he is required to do. An infraction of nature's law brings inevitably a punishment, mild or severe. It seems, therefore, fair and reasonable that the employee, after assuming his obligations, should be held to a strict accountability, and that a reprimand, suspension, or dismissal should follow an infraction of his instructions. Before inflicting the penalty, however, ample opportunity should be given him to present fully his side of the case, and action deferred until his fault or blamelessness has been clearly shown by good evidence.

After many years' experience, I have yet to see men fail to recognize and acquiesce in decisions arrived at by this method; and still more positive confirmation of its value is found in the remark, made to me by a distinguished railroad manager, that, after thirty years' service in charge of large numbers of men, and during that time having reprimanded, suspended, and dismissed a great many, he could not recall a single instance where such men did not continue to be his friends. What stronger proof could be offered that his relations with the men were governed by justice and fair dealing?

To impress the employee with the fact that justice will be done, as contemplated in proposition five, it is necessary to treat all infractions logically, and to attend closely to those small details which affect his relation to the company. This, for the busy manager, is difficult; and it will be said that, with all this care and attention on the part of the manager, or superintendent, there will be many employees on whom it will have no effect. This is true; but this very method of investigating acts and judging conduct becomes at once the active agent for ridding the service of such men, while a marked raising of character will be observed in those who are amenable to its influence, so that the efficiency of the service will be improved at both ends, and in a most striking manner, indicating how essential is constant vigilance on the part of the manager to the development of the efficiency which it is aimed to secure.

We must remember the great magnitude of the railway interests, and that nearly the whole of their wonderful development has taken place during the past fifty years. The railway corporation, even more than any other, is of necessity entirely removed from contact with the men, and the managing officer should aim to serve as a link connecting the interests of the men with those of the corporation. Personal contact, even by the manager, is necessarily infrequent and spasmodic, but all the advantages of personal contact can be secured by the just and impartial review of questions which arise between the men and subordinate officers. While the decisions thus rendered can serve as precedents for the determination of similar questions as they again arise, in this manner also the caprice of judgment shown in passing on similar offences on separate portions of the line can be corrected, and all divisions be brought to act in unison, this uniformity of action forming an essential part of that justice which is deemed essential to good discipline.

The public are daily becoming more exacting, and of necessity the railways must meet the changed conditions. The older employees

must of necessity adapt themselves to the new order of things, which means, in many instances, a change in the habits and practices of years. This can best be accomplished by appealing to their reason, as indicated above, and gradually bringing them to act from proper motives, through conviction that good results will be attained thereby.

As one illustration of the effect of appealing to men's understanding, I will cite the following:

It became necessary to change the location of a division terminal, in consequence of which the runs of one end were made much shorter than those of the other. Soon after, the men making the shorter runs demanded the same remuneration that they had received for the mileage formerly made, although the men on longer runs, under the new arrangement, did this work, and received the pay for it. It was claimed that the division time-card had not been changed, and the men insisted that the time-card distance should rule. Answer was made that their request would be granted, and they must decide for themselves whether the time-card distance or the actual distance run should govern. The time-card distance was at first decided upon; but, when it was shown that, if the time-card distance governed in the one case, it must also govern in the other—that, if the men of one division received pay for thirty miles which they did not run, the men on the other division, under the same rule, would run thirty miles without receiving any pay for the same—the men reconsidered their request, their acquiescence to the existing arrangement being given in such a manner as to leave no doubt of their conviction of its justice.

To show the force of emulation, I may state that, while in charge of a track division comprising fifteen sections, each under a foreman, I have repeatedly instructed seven of the foremen to perform work at the ends of their sections tending to improve materially the condition and appearance. In no single instance did I fail to find the eight alternate foremen doing the same work not later than the second day, although no instructions whatever had been given them, the contrast and improved appearance of the adjoining section impelling them to similar action. In this manner the men are mentally and morally strengthened, while the quality of their service is much improved.

The apprentice who enters the railway machine-shop with proper qualifications for success will in good time become a master workman, capable of directing the building of a modern locomotive. Such men, taken as a class, will be men of fixed ideas and purpose. Their work has required exactness in every detail, performed under the watchful care and within reach of the helping hand of a resident official.

To place such a man in charge of the machine he has built, which, in its frequent trips, by night and day, surrounds him constantly with uncertainties, calling for exercise of individual judgment and the faithful discharge of duty in the absence of all personal supervision, is to change absolutely his environment, and consequently his ideas and inclinations; and, although the same person, yet he is in an entirely different class, requiring different treatment, all of which should and will be considered by the intelligent officer. In other words, the latter will recognize the plain distinction between employees whose duties tend to fixed results, and those whose duties are full of uncertainties, as in train service.

Absolute frankness upon the part of those in authority, when dealing with the men, forms an essential part of the relations which the railway company should bear to its employees. If requests are made which cannot consistently be granted, it should be answered that such is the case, it being far better that the employee should be disappointed at the time rather than suffered to entertain hopes not to be realized in the future.

In many instances promises of promotion are made with an undoubted intention to fulfil them; and yet, as every officer knows, circumstances over which he has no control arise to prevent the fulfilment. Not only are such failures disappointing to the parties directly interested, but they involve a lowering of confidence in the minds of the employees in general, which must tend to weaken discipline, however slightly. As no explanation can change these feelings, avoidance of promises is the wiser course.

In acceptance of new men for the various branches of the service, it is of advantage to the company, and positively due to the men already employed, that the existing standard of efficiency should be maintained. To this end suitable references should be required, with the understanding that the applicants will not be employed until such references have been looked into, and assurances received that the applicant is worthy in character and gives evidence of capacity, as only by such discriminative methods can justice be done to the employees whose capacity has been proved.

In the relations of the railway to the employee, it is the part of wisdom for the railway officer, when positions become vacant, to promote, whenever possible, some one of the employees already in service. It is true that in the strict sense the obligation of the company to the employee ceases when the stipulated sum has been paid him for the service rendered; it is equally true that with the performance of a fair

month's work the employee has discharged his full duty ; but, as we seek to increase the efficiency of the service, evidences of unusual loyalty and energetic performance of duty should be met with due recognition by promotion to such positions as call for the exercise of the qualities displayed.

Since the improvement of the men is an advantage to the service, there is much to be gained by railway companies in taking an interest, and aiding pecuniarily, in the provision of suitable quarters at principal points where employees can spend their leisure hours surrounded by good influences. In this way the Young Men's Christian Associations have rendered valuable service, and it is a pleasure to note the rapidly-increasing interest shown in this direction by many railway officials, and the appreciation of such efforts by the employees, as evidenced by increasing attendance and interest, thus conclusively proving the good results upon men when they become impressed with the evidence of concern for their personal welfare.

Thus it is that we find large numbers of men engaged in an occupation the nature of which requires keen perception and close adherence to fixed rules. Any failure on their part may result in loss of property or danger to human life—a most exacting service ; yet, considering the interests involved in the movement of freight and passenger trains, how faithfully their service is performed ! But success in this, as in any other form of government, can only come with close study and constant watchfulness.

The relations of the railway to the employee being impersonal, the manager must in his own person fill the void. The employee is, in a great measure, what the manager's conduct makes him. If the manager desires an interest in the work aroused, he must show an interest in the men. When strict and intelligent obedience to the rules is demanded, the manager must not shrink from a strict and intelligible construction of them. If he wants the employees fearlessly to discharge their duties, he must as firmly uphold them where no blame is shown.

When more than usual zeal is manifested, promotion is a wise means of proving appreciation. Wisdom in judgment will command respect, honesty of purpose will win confidence ; and, when these reciprocal obligations are recognized and performed, the relations of each to each will be better understood, a more friendly feeling will arise, fewer strikes will prevail, and, in the determination of the honest differences which may arise, the convictions of reason will prove a more potent factor than coercive force.

STRENGTH AND WEAKNESS OF THE COMBINATION OR TRUST IDEA.

A SYMPOSIUM OF EXPERT OPINIONS.



O special publication devoted to problems of organization and management, as this is, would be complete without some practical discussion of the principle of consolidated industries, or Trusts, of which we have seen such phenomenal development within the past three years. Unfortunately, however, the subject has been fairly written to death. But the problem will not down, and as yet it is still far from the point of final settlement.

Moreover, these great industrial combinations are now in existence, and in England at least the movement to form new ones is still in active progress. It is of the first importance, therefore, that the practical men who succeed the financiers in the actual management of these vast enterprises shall clearly understand the underlying principles of their organization.

As the most effective means of making these principles clear, therefore, it has seemed to us appropriate to quote the best that has already been written by acknowledged authorities *pro* and *con*, rather than to attempt to write anything new. Fortunately, too, the past half year has given us three very notable expressions of opinion from authorities of unquestioned standing and influence in the United States, where the trust movement has been carried to its highest development; and these, added to the memorable declarations of Lord Chief Justice Russell during the last two years of his life, make a symposium of expert opinion which should leave no man in doubt as to the essential principles and conditions which must govern industrial enterprise in the light of this modern development.

MR. ROCKEFELLER AND STANDARD OIL

The fruitful parent of all the trusts that have been formed in the United States is the Standard Oil Company. That is not only the oldest, but it is the strongest aggregation of capital and business capacity ever yet drawn together in any branch of productive enterprise outside

railway operations. Matchless in the perfection of its organization, astonishing in its economies of production, and more astonishing in the low prices at which its products are marketed, it is the model from which every argument in support of the trust idea has been drawn. And so often and so furiously has it been attacked by press and pulpit, state legislatures, legal functionaries, and reformers of every kind and degree, that the American people have come to look upon it as a thing which must endure because of the essential soundness of the principles upon which it is builded. But the secrets of its strength are perfectly obvious to men who are trained in economic thought; and fortunately we have lately had from Mr. John D. Rockefeller, its creator and organizer, an authoritative statement clearly indicating the character of the Standard Company's business, and frankly stating its policy, methods and aims. This is not only the very ablest argument ever yet published in advocacy of the combination principle, but its perfect openness of statement, in contrast with the prevailing policy of secrecy in company affairs, shows plainly that Mr. Rockefeller and his associates now clearly recognize that publicity is the surest safeguard of legitimate manufacturing enterprise.

Summoned before the Congressional Commission, sitting in Washington to investigate the trust problem, Mr. Rockefeller was presented with a series of questions, to which he replied in writing. Beginning his statement with a direct reply to the question, What was it that induced the original combination of firms in the oil business, Mr. Rockefeller said:

"The desire to unite our skill and capital in order to carry on a business of some magnitude and importance in place of the small business that each separately had theretofore carried on.

"As the business grew and markets were obtained at home and abroad, more persons and capital were added to the business and new corporate agencies were obtained or organized, the object being always the same—to extend our business by furnishing the best and cheapest product.

"I ascribe the success of the Standard to its consistent policy to make the volume of its business large through the merits and cheapness of its products. It has spared no expense in finding, securing and utilizing the best and cheapest methods of manufacture. It has sought for the best superintendents and workmen, and paid the best wages. It has not hesitated to sacrifice old machinery and old plants for new and better ones. It has placed its manufactories at the points where they could supply markets at the least expense. It has not only sought markets for its principal products, but for all possible by-products, sparing no expense in introducing them to the public. It has not hesitated to invest millions of dollars in methods for cheapening the gathering and distribution of oils, by pipe lines, special cars, tank steamers and tank wagons. It has erected tank stations at every important railroad station to cheapen the

storage and delivery of its products. It has spared no expense in forcing its products into the markets of the world, among people civilized and uncivilized. It has had faith in American oil, and has brought together millions of money for the purpose of making it what it is, and holding its markets against the competition of Russia and all the many countries which are producers of oil and competitors against American oil.

"Much that one man cannot do alone two can do together, and once admit the fact that co-operation, or, what is the same thing, combination, is necessary on a small scale, the limit depends solely upon the necessities of business. Two persons in partnership may be a sufficiently large combination for a small business, but if the business grows or can be made to grow, more persons and more capital must be taken in. The business may grow so large that a partnership ceases to be a proper instrumentality for its purposes, and then a corporation becomes a necessity. In most countries, as in England, this form of industrial combination is sufficient for a business co-extensive with the parent country, but it is not so in this country. Our Federal form of government, making every corporation created by a State foreign to every other State, renders it necessary for persons doing business through corporate agency to organize corporations in some or many of the different States in which their business is located. Instead of doing business through the agency of one corporation, they must do business through the agencies of several corporations. If the business is extended to foreign countries—and Americans are not to-day satisfied with home markets alone—it will be found helpful and possibly necessary to organize corporations in such countries, for Europeans are prejudiced against foreign corporations, as are the people of many of our States. These different corporations thus become co-operating agencies in the same business, and are held together by common ownership of their stocks.

"It is too late to argue about advantages of industrial combinations. They are a necessity. And if Americans are to have the privilege of extending their business in all the States of the Union and into foreign countries as well, they are a necessity on a large scale and require the agency of more than one corporation. Their chief advantages are:

"1. Command or necessary capital.

"2. Extension of limits of business.

"3. Increase of number of persons interested in the business.

"4. Economy in business.

"5. Improvements and economies which are derived from knowledge of many interested persons of wide experience.

"6. Power to give the public improved products at less prices and still make profit for stockholders.

"7. Permanent work and good wages for laborers.

"I speak from my experience in the business, with which I have been intimately connected for about forty years.

"We soon discovered as the business grew that the primary method of transporting oil in barrels could not last. The package often cost more than the contents, and the forests of the country were not sufficient to supply the material for an extended length of time. Hence we devoted attention to other methods of transportation, adopted the pipe line system and found capital for pipe line construction equal to the necessities of the business. To operate pipe lines re-

quired franchises from States in which they were located, and consequently corporations in those States, just as railroads running through different States are forced to operate under separate charters. To perfect the pipe line system of transportation required in the neighborhood of \$50,000,000 of capital. This could not be obtained or maintained without industrial combination.

"The entire oil business is dependent upon this pipe line system. Without it every well would be shut down, every foreign market would be closed to us. The pipe line system required other improvements, such as tank cars upon railways, and finally the tank steamer. Capital had to be furnished for them, and corporations created to own and operate them. Every step taken was necessary in the business if it was to be properly developed.

"The dangers are that the power conferred by combinations may be abused, that combinations may be formed for speculation in stocks rather than for conducting business, and that for this purpose prices may be temporarily raised instead of being lowered.

"These abuses are possible to a greater or less extent in all combinations, large or small, but this fact is no more of an argument against combinations than the fact that steam may explode is an argument against steam. Steam is necessary, and can be made comparatively safe. Combination is necessary, and its abuses can be minimized; otherwise our legislators must acknowledge their incapacity to deal with the most important instrument of industry.

"Hitherto most legislative attempts have been an effort not to control, but to destroy, hence their futility."

In order to estimate correctly the force and application of this statement from Mr. Rockefeller's pen, it is very necessary to bear in mind that he is referring directly to a great manufacturing enterprise founded primarily upon a natural monopoly. The supply of crude petroleum is limited rigidly by the flow from known oil fields. The problem with which Mr. Rockefeller and his associates have to deal, therefore, is to get control in each new oil field as it develops. Having in the course of years secured control of existing sources of supply, it is now a simple matter, with their enormous capital, their many miles of pipe lines, their great storage facilities, their thousands of tank cars, and their fleet of tank steamers—with these advantages, it becomes an easy matter speedily to gain control in each new oil field as it develops. These are the features of the Standard Oil Company's business which broadly distinguish it from every other branch of manufacturing and commercial industry; and it is here that the principle of combination and co-operation between closely allied companies has been legitimately and most wisely employed, with unexampled reward for all those who have participated in Mr. Rockefeller's enterprises.

MR. CARNEGIE AND COMPETITION.

And as Mr. Rockefeller's strong logic and matchless achievements convince us that combined ownership and centralized control must in

time supplant all other systems in the conduct of enterprises which may be classed as natural monopolies, so we have Mr. Andrew Carnegie, an equally distinguished authority, stoutly maintaining that in the field of manufacturing industry and commerce, competition is still the order of the day. Mr. Carnegie, no less than Mr. Rockefeller, is a consistent advocate of centralized control, production upon the largest possible scale, and the quick employment of every system and device that can lower the costs of production and enlarge his markets by meeting all possible competition. But he has refused to consider every proposal looking to the consolidation of his business with other interests in the iron and steel trades; and in May last he contributed a paper to *The Century* magazine, under the title "Some Popular Delusions About Trusts," from which we make the following characteristic extracts.

"The people are aroused against trusts because they are said to aim at securing monopolies in the manufacture and distribution of their products; but the whole question is, Have they or can they succeed in monopolizing products? Let us consider.

"There are only two conditions other than patents which render it possible to maintain a monopoly. These are when the parties absolutely control the raw material out of which the article is produced, or control territory into which rivals can enter only with extreme difficulty. Such is virtually the case with the Standard Oil Company, and as long as it can maintain a monopoly of raw materials it goes without saying that it can maintain a monopoly in the product. This is a fact that the public must recognize, but what legislation can do to prevent it is difficult to say. * * * Its second source of strength lies in the fact that through its extensive operations it has been enabled to reduce the price of its product to the consumer. It is a unique organization, for there is nothing like it in the world, and therefore it is not to be classed with the ordinary trusts.

"The genesis of trusts is as follows: Manufacturers of most staple articles (especially of iron and steel) are subject to long periods of serious depression, succeeded by short intervals of high profits. Because during depression no increase is made in capacity, and the world's population and wants are constantly growing, one morning it is discovered that demand has overtaken and outrun supply. But the production of increased supply is no easy matter. It usually means beginning at the beginning, obtaining the raw materials from mine or soil, passing these through various processes for which the necessary machinery and facilities are wanting, and it is a year or eighteen months, or even two years, before the supply of most articles can be materially increased. Demand becomes imperious and unsatisfied, and prices bound upward. Many new men are induced to build new works. The extensions of the old works supply all demands, and even a shade beyond; then comes the collapse. It is during one of these long periods of depression, when many of the manufacturers are on the verge of bankruptcy, that there arises in the heart a hope, soon crystallized

into a belief, that a new way has been found to avoid the natural consequences of the unchanging economic laws. It is soon felt that savage competition should cease between those enduring a common affliction, who should be brother manufacturers, and that the lion and the lamb should lie down together. They forget, in the hour of their misery, that the moralist has expressed the fear lest the one may be found inside the other. First, all kinds of understandings and fair promises are made—alas! only to be broken; and, finally, the promoter makes his appearance, and our unfortunate manufacturers fall an easy prey. Enormous sums are offered for antiquated plants which may not have been able to do more than pay their way for years. These are tied together, and the new industrial makes its appearance as a trust, under the delusion that if a dozen or twenty invalids be tied together vitality will be infused thereby into the mass. This is not true of all that are classed as trusts; there are exceptions. I speak only generally.

"Should these combinations be made upon the eve of a period of activity, as was the case recently, then there is a triumphant vindication of the new nostrum, the industrial world has found its panacea for all ills, and there is never to be ruinous competition again. The public is alarmed; it hears for a time of the advance of prices in the products of these gigantic concerns which temporarily control the market, and demands legislation against them. Generally speaking, as in the present instance, the advance in prices would have taken place even if no trusts existed, being caused by increased demand. The very name of trust stinks in our nostrils. We believe the public to be needlessly alarmed upon the subject, for the following reasons:

"Few trusts have a monopoly through patents or through the supply of raw material or of territory, and what happens is this: For a short time competition is hindered, but rarely, if ever, completely stifled. The profits of the trusts are high, and capital, ever watchful for an opportunity to make unusual gains, seeks its level by a law of its being, and needs only the opportunity to engage in this highly profitable manufacture. A relative of one of the principal officials or one of the chiefs of a department in the trust, knowing its great profits, gets some friend with capital to build new works in co-operation with him, and the result is that we soon see springing up over the country rival works, each of which has the great giant trust more or less at its mercy. A threat to reduce prices, and the trust, to which this may mean millions of dollars of loss, will sooner or later come to an agreement with the little David who threatens to attack the Goliath, and the rival concern is arranged with or purchased. This only whets the appetite of others who see the success of the first innovator, and other works soon spring up. No sooner has the trust purchased one threatened rival than two appear, and the end is disaster. The people may rest assured that neither in one article nor in another is it possible for any trust to exact exorbitant profits without thereby speedily undermining its own foundations. It is not long since trusts first made their appearance, and already many have disappeared. Many still existing are being assailed, the names of which will readily occur to our readers. Only a few survive to-day, and none have secured the coveted monopoly. Most of the metals and many of the staple articles have been formed into trusts, which, although yet living, are rapidly being attacked to their final destruction. The press used to tell every morning of the organization of some trust or other, and even to-day we will hear of proposed additions to the list

of these attempted gigantic monopolies, which enjoy a brief ephemeral existence. Upon most of them can already be written the appropriate epitaph:

"'If I was so soon to be done for,
I wonder what I was begun for.'

"Every attempt to monopolize the manufacture of any staple article carries within its bosom the seeds of failure. Long before we could legislate with much effect against trusts there would be no necessity for legislation. The past proves this, and the future is to confirm it. There should be nothing but encouragement for these vast aggregations of capital for the manufacture of staple articles. As for the result being an increase of price to the consumer beyond a brief period, there need be no fear. On the contrary, the inevitable result of these aggregations is, finally and permanently, to give to the consumer cheaper articles than would have been otherwise possible to obtain; for capital is stimulated by the high profits of the trust, for a season, to embark against it. The result is very soon a capacity of production beyond the wants of the consumer, and as the new works erected are of the most improved pattern, and capable of producing cheaper than the old works, the vulnerable trusts are compelled to buy and capitalize at two or three times their cost. There is thus no danger ahead to the community from trusts, nor any cause for fear.

"The great natural laws, being the outgrowth of human nature and human needs, keep on their irresistible course. Competition in all departments of human activity is not to be suppressed. The individual manufacturer who is tempted into the unusually profitable business of the trust will take care of the monopoly question and prevent injury to the nation. The trust, so far as aggregation and enlargement go, is one day to be recognized as a grand step toward cheaper products for the people than could have been obtained by any other mode than the aggregation of capital and establishments. Already the ghosts of numerous departed trusts which aimed at monopolies have marched across the stage of human affairs, each pointing to its fatal wound, inflicted by that great corrective, competition. Like the ghosts of *Macbeth's* victims, the line promises to stretch longer and longer, and also like those phantoms of the brain, they 'come like shadows, so depart.'

"'The earth hath bubbles as the water hath,
And these are of them.'

"The masses of the people, the toiling millions, are soon to find in this great law of aggregation of capital and of factories another of those beneficent agencies which in their operation tend to bring to the homes of the poor, in greater degree than ever, more and more of the luxuries of the rich, and into their lives more of sweetness and light. The only people who have reason to fear trusts are those who trust them."

If these two high authorities seem to differ radically as to the scope and application of the principle of combination, there is yet a striking similarity in the methods and careers of the two men. They are of one mind as to the wisdom of keeping the reins of control firmly within their own grasp; they have firm faith in the policy of production upon the largest possible scale; they know the power of low prices in enlarging markets and increasing consumption; they meet and overcome

competition by underselling it; and each man, with a singleness of purpose rarely seen, has devoted a lifetime to the development of the great enterprise which has yielded him vast and rapidly increasing wealth. The careers of both men give eloquent testimony to the homely truth that great business success comes most surely as the reward of intelligent, continuous, and concentrated effort, prolonged through many years, and highly specialized in one calling. Until lately that homely rule has held true of all business and all countries. But in these piping times of great prosperity, great business, great opportunities, and great fortunes quickly made, the old order seems, for the time-being at least, to have been superseded by a new era and a new *régime*. The practical man of business, the trained engineer, the manager, and the superintendent have all been superseded—in authority surely—by the promoter and the financier.

MR. DILL AND THE PROFESSIONAL PROMOTER.

We are quite prepared to sympathize with the view that the modern promoter and the underwriting financier have probably performed a useful function. But this Magazine is published and these pages are written in the interest of experts who devote their lives to the study and practice of the science of industrial management and constructive enterprise. We hold that, if the great combinations now formed and yet forming are to fulfill the representations of their sponsors and reward the faith of thousands who have invested in their shares, that can only come by quickly superseding the authority and influence of the promoter and financier by that of the practical man of proved capacity, with his staff of trained engineers, managers and superintendents. To that end, nothing can be more important than that the men to be charged with these responsibilities shall clearly understand the methods, the motives and the rewards of both the promoter and the financier. And happily we have at hand a very clear statement of this essentially important phase of the problem, from Mr. James B. Dill, the distinguished attorney of New York and New Jersey, who is credited with being the legal counsellor and having drawn the charters for a larger aggregate capitalization of great industrial enterprises than any other man now living. In the course of a notable public address last summer, Mr. Dill said:

“The labor of the professional promoter in this matter was not one of love. He was not actuated by methods of mere philanthropy; his purpose was to make for himself a profit out of the combination. This was generally done by making the stock issue of the company of sufficient size to enable the promoter

to get some of this stock. The manufacturer was inclined to be generous with that which apparently cost him nothing. * * * The promoter was not working upon the corporate problem to demonstrate an economic proposition from the standpoint of economics. He was seeking his reward, which was a block of stock. * * * His stock sought a market, and this brought the promoter into contact with the men who marketed the stock.

"We have now the origin of the financier.

"The financier saw that the promoter obtained his stock for his services, and that the stock was created for the purpose of paying for the services. * * * At this point another element arose which tended to increase the issue of watered stock.

"Instead of \$500,000 propositions, propositions involving millions were sought for, in order that the promoter's and financier's reward might be in the millions rather than in the unit quantities, and perhaps with a view to make the ascertainment of the exact amount paid for promotion more difficult.

"There followed a tendency to surrender industrial principles, and to follow the promoter and the financier along promotion lines, rather than along truly manufacturing, mercantile, or industrial lines. What was the result? The answer is plain.

"Combinations began to be put together for speculative purposes, or, put it another way, the Wall Street end came prominently forward into the business of combinations. For the Wall Street purpose, it was necessary that the combinations should be of immense size and apparently involving whole trades. Neither the promoter nor the financier was able to dispose of it all, and therefore a market had to be created for it.

"This tended to create the so-called pirates among industrial combinations, sometimes designated as 'gambling specialties,' a class of corporations organized as industrials upon apparently economic principles, but really and truly for the purpose of Wall Street speculations, and speculations only.

"In such companies the director or trustee had largely disappeared so far as his duties as an impartial trustee for the stockholder, the wage earner, or indeed, the industry or business itself, was concerned. The tendency was that of a mad race to quick wealth; sometimes proceeding upon the principle that the end justified the means, forgetting that industrial enterprises could not be conducted on purely speculative or gambling methods.

"At this point, let it be clearly understood that by no means all combinations were improperly promoted, viciously financed, but be it confessed that some were.

"As to the future of those corporations which are overloaded with stock issues, whose valuations have been fictitious, whose aims have been speculative, we note that the organization of these companies, while ostensibly upon economic lines, has been really for the purpose of stock speculations. But the opportunity for this speculation is daily growing less and less; the investing public are becoming aware of securities of organizations which are over capitalized; the American public are buying with more care, are making more inquiries, are becoming more inquisitive as to what is behind the stock issue, and with the result that the market is lost to industrials which are in the nature of gambling speculations. The result will be that by a process more or less painful to the over-capitalized institutions, reorganization will take place, and such combinations will be put upon a truly industrial footing, or go to the wall.

"One thing certainly is now in the minds of the corporations of integrity, viz., to show plainly to the public what is back of the entire issue of stock, common and preferred. The public must have knowledge in order to buy and invest. The corporations must make knowledge public in order that they may not all go to destruction, and that the bad may stand out from and be distinguished as against the good.

"The so-called pirates in combinations have been the greatest injury to honest corporations of any of the elements existing to-day. For their own preservation corporations of integrity are urging a separation between the good and the bad. This is because the honest corporations know that they can stand that degree of publicity, while the inflated organization, the false industrial, will not dare make the same showing. The same need which called for the enactment of the national bank law (requiring official examination and periodical public statements) will no doubt eventually call for a national control of, and a national corporation law for, corporations which are truly national in their extent. This is but in a legal way carrying to its logical conclusion the principle which caused the organization of the combination, namely, 'centralization of control.' Applying this same principle of centralization of control to the law governing the corporations results in a national corporation law."

THE LATE LORD RUSSELL AND PUBLICITY.

Mr. Dill's expert and timely emphasis of the growing need, in defense of both stockholders and managers, for greater publicity in company affairs, is but an echo of the eloquent, forceful, and oft-repeated warnings upon the same subject from the late Lord Chief Justice Russell. Following the Hooley disclosures, it will be recalled that in his memorable address at Manchester, he said:

"That law has effected much good, but it has been, I am sorry to say, in many cases * * * prostituted by the greed of unscrupulous persons in the hurry to obtain great wealth without being willing to put forth for its acquirement honest toil and honest endeavour. * * * The problem, which is not yet solved by existing legislation, is to reconcile the useful operation of that act with such machinery as, if it cannot wholly prevent, will minimise evils of the nature and character to which I have referred.

"The first object ought to be to ensure, so far as practicable, that the public should be afforded all such information as would affect the reasonable judgment of a man in determining whether he would or would not invest in a particular concern; and the next object ought to be that all holding fiduciary or quasi-fiduciary positions should be bound to disclose fully and clearly any interest which they possess differing from the interests of the other shareholders—in other words, that the transactions should be open and above board, and all the parties dealing on equal terms.

"I have heard it said that it is impossible to make the law more stringent, because it will frighten away from the direction of public companies honourable and honest men. I do not say that that consideration is to be disregarded—far from it. But I do not believe that any honourable and honest man, who desires according to his conscience to discharge the trust that is imposed on him.

would suffer by any greater stringency of the law to give effect to the two objects to which I have referred. I said a few minutes ago that great pecuniary losses had followed these nefarious practices. The official receiver charged with winding up of public companies, who has rendered and is rendering the most valuable public service, has at my request furnished to me some figures on this head. They are startling. He gives me the figures for a period of seven years—from 1891 and up to and including 1897, and on the official information at his command, and taking the advice of those in a position to check the estimate (for in part it must necessarily be an estimate), he comes to the conclusion that in that period of seven years there has been lost to the community, and gone into unworthy pockets, no less a sum than £28,159,482, made up of losses of creditors dealing with companies £7,696,848, and of loss to the wretched contributors or shareholders £20,462,634. And when you recollect that these are the figures relating only to companies wound up compulsorily, and that they exclude cases of reduced capital, the losses in relation to companies whose shares were taken by the public at par, but whose present value only represents a very few shillings or pence in the pound of their par value, you will see that the loss to the public is enormous. But in addition to that is what I think is a weightier consideration—the effect of such transactions, if allowed to go on almost with impunity, on the public mind and confidence. These are pressing considerations, which show that these matters should be dealt with as of urgent importance.”

Then again, a little over a year ago, at the inauguration of the Lord Mayor of London, he took occasion to say :

“The Legislature has recognised the need of measures aimed in this direction, for in several sessions of Parliament, Committees of the House of Lords have been endeavouring to solve in this relation the problem of how to prevent, or at least to narrow, the area of fraud, while at the same time not interfering with the useful efficiency and operation of the acts dealing with limited liability companies. The aim of any such legislation is clear and is simple. It is to enforce the rules of common honesty in the promotion of companies. When appeals are made to the public to subscribe to the capital of undertakings, it ought to be obligatory to disclose every fact known to the promoters and unknown to the public which might affect the mind of a reasonable person in determining whether he will or will not subscribe to the purpose of the undertaking. Everything ought to be above board; no concealment; no secret profits—the parties, public, and promoters alike ought to deal with equal information as regards the carrying on of such companies. The directors ought to be men of independence, not the creatures of promoters, paid by promoters, qualified by promoters, but men bringing reasonable skill and knowledge to the matters they undertake, and, even more important, independence of mind and perfect honesty to their task. My Lord Mayor, in saying this, I am not uttering any counsels of perfection. I am saying what the commonest dictates of honesty—common honesty—suggest. I hope that Parliament will feel itself competent at an early date to deal adequately and efficiently with this subject.”

However men's interests, prejudices or convictions may cause them to differ upon these subjects, there are three conclusions to be

drawn from this array of expert opinion, in which all fair-minded men will probably be in agreement. They are these:

(1) In the operation of all natural monopolies, including railways, tramways, water works, gas works, and public utilities generally, the system of consolidated ownership and centralized control will gradually supersede all others—obviously because it admits of the most perfect organization, the highest economy in operation, and the best public service at the least price consistent with a fair return upon the capital invested.

(2) But in strictly manufacturing industry, competition is still the order of the day, as it must continue to be; and that firm, big or little, which can manufacture cheapest, sell lowest, and conduct its business with most skill and enterprise, is certain to survive. This means also and especially that it is the part of wisdom and foresight for such a firm to strengthen its position by acquiring a controlling interest in closely allied firms—as Lord Armstrong's firm has done in equipping itself to produce in its own yards a completed battle-ship; and as Mr. Carnegie has done in providing his firm with ample supplies of the best ore and coke. Every such move is a wise one when made to strengthen one's position, in recognition of the fact that "the survival of the fittest" is the obvious law of the manufacturing world.

(3) Finally, the interests of investors, and the kindred interests of industrial managers who require capital, plainly demand that these great industrial corporations, especially those listing their shares on the stock exchanges, shall be speedily required to give their stockholders and the investing public the benefit of that degree of publicity as to their affairs which has done so much to give stability and character to the investment shares of banking, insurance, and railway companies.



EDITORIAL COMMENT



N technical journalism the special number must be the chronicle of some majestic occasion, or the herald of a great movement. If its theme is not of a high order, itself will lack not only dignity but also ser-

viceableness and worth to its constituency; it will become a thing of sound and surface, wearisome to all. But when it is really infused with the power of some great work, seizing upon the essence and not the mere ornament; when it is inspired by a great conception, tracing its movement through the entire body of the industrial economy—the special number becomes the exponent of an era, important for all time

The World's Fair Number of THE ENGINEERING MAGAZINE, the first great effort of the kind in engineering journalism, was the natural outgrowth of the greatest industrial exposition the world had seen up to that date. America then made her first striking appearance in the international congress of engineering, and the digest of results, presented in these pages in January, 1894, marked a new departure in engineering literature. That special number was pre-eminent through the magnitude of its subject and through its voiced recognition of the yet unfamiliar fact that commerce and manufacture were breaking through political boundaries, and that engineering practice must follow in making its range international.

* * *

Advance since that time in all lines—and especially in industrial expansion—has been so stupendous as to make one

ready to accept the ratio quoted by Mr. Porter in his article in this issue—that the progress of each year equals that achieved in the preceding two years. The marvels of that day have become the common-places of this; the mysteries of 1894 are the axioms of 1900. Electricity alone, as Dr. Bell points out, has experienced a development in the last decade of the century perhaps greater than steam had attained in the other nine, and the growth is particularly evident in the case of electricity only because this branch of applied science is comparatively young and the scale is more easily applied. Throughout the entire range of engineering activity the same process is apparent—the process of bringing higher units of force under more absolute control of the individual will. This is the new order of economy in production, as Prof. Hutton indicates, in which lies in great part the solution of the problem of increasing population.

* * *

On the material side the advance of the era is strikingly evident. It shows first, perhaps, in the vast manufacturing establishments, some of the greatest of which are described and pictured in this volume, and in the parallel rise of huge central power and lighting stations, swift steamships, fast railway trains, extended traction systems, great office buildings. Next, it shows in the change in the mechanical equipment of all of these—a change amounting to a revolution, especially in the tools of production used in the mill and machine works, impressive examples of which are given by Mr. Porter. Surely it must be apparent that there must be an equal progress in the system of co-ordination by which these tremendous agencies are made to work in internal and external harmony—in other words, in methods of management—and this, as has recently

been pointed out in these pages, not as an auxiliary to, but as an integral part of, the modern system of production.

The development of works management into a specialised branch of productive activity is indeed the great co-ordinate of the mechanical progress of the last few years, and it is to the founding of the recognised literature of this new applied science—to the formulation of the principles of Industrial Engineering—that this special number of *THE ENGINEERING MAGAZINE* is dedicated. And the resultant volume surpasses any former effort of the sort because the theme is richer in possibilities—because a great movement in human activity, full of the stirrings of vital power, is greater than any event, even one so full of meaning as a world's exposition.

* * *

Each new field of creative work has brought out a new army of specially trained workers, making a new section of the engineering profession. With the first uses of power began the differentiation of mechanical engineering, later subdivided still further into special sections; more recently still, the insistent demands of electricity raised up the new profession of the electrical engineer. But, as Mr. Gunn points out in another part of this magazine, these workers deal rather with processes and mechanical methods. The definite adjustment of these to commercial ends—the combination and adjustment of the productions of the civil engineer, the mechanical engineer, the electrical engineer, the architect, with the many human agencies employed, so that, as Mr. Orcutt argues, the whole works shall operate smoothly and efficiently as one great tool in which the various men and machines are the moving parts—this has become a new applied science, and Industrial or Production Engineering demands from the twentieth century due recognition as an equal member of the great family of engineering sciences to which the

world owes so much. Like its fellows, it has application in every department of profitable industry. In the machine-shop, the power-plant, the railway, the mine—the processes of selection, co-ordination, supervision, and recording with which it concerns itself are absolutely demanded by the conditions and the vast scale of present-day workings. Regarded subjectively it is highly-specialised; regarded objectively, it is most widely general. And in the fullest sense it fulfills the definition of engineering, "Directing the forces of nature to the use and convenience of man," and that other somewhat less-quoted one, "Common sense applied to the use of materials."

* * *

That it is an exact science must be evident to anyone reading in these pages; the fundamental propositions are already crystallised into theorems accepted by all its professors. If these professors are not yet recognised as a distinct body, it is only because, as Mr. Gunn says, their science has awaited the creation of a literature—perhaps it would be more nearly correct to say the codification of its principles in literary form. Action has proceeded so rapidly that it has almost outrun its chroniclers, and is to be found in the concrete in practice more easily than in formulation in treatises. But in the forefront of its progress certain examples stand clearly typical of its best principles, and among its disciples certain leaders find the opportunity to epitomise their conclusions, and in the records of example and precept the literature of Production Engineering begins to assume volume.

And that literature it is the function of *THE ENGINEERING MAGAZINE* to embody. For four years the library has been accumulating. In this first issue of the Twentieth Century, the Magazine presents, in this special Works Management Number, the first great conference of the world's leading authorities on Production Engineering.



REVIEW OF THE BRITISH PRESS

The Capacity of Railway Wagons.

AN important matter in connection with the much-discussed question of American competition lies in the relatively lower cost of transport in the United States over that in Great Britain. This difference is claimed to be due to various causes, but one of the most important is that of the greater capacity of the wagons, or, as they are called in the States, of the cars. The question of the capacity of railway wagons as affecting the cost of transport forms the subject of a paper presented before the Institution of Mechanical Engineers, by Mr. J. D. Twinberrow, and in the present state of railway transport in the United Kingdom the subject is especially timely.

An examination of the reports of railway working in the annual report of the Board of Trade shows that the increase of capital is nearly double that of the growth of the amount available for meeting interest charges. Diagrams plotted from the data given in the report show that the earning capacity of trains is slightly less, whilst the cost of working them is increasing. Any improvements which may have been effected in the construction of locomotives and rolling stock and in engineering practice have not been of sufficient moment to counteract the increasing cost of fuel and materials. "The principal factor in reducing the cost of a product is the economy of labour in its manipulation, and this is effected in modern industries by improvements in plant or tools whereby both the output and the remuneration of labour are increased; the results of railway working in the British Isles afford no evidence of the adoption of that principle to this important branch of industry. The useful product of railway working is the passenger or ton-mile; since these units determine the earnings, they should also form the basis for calculating the costs; but it is customary to refer the expenses of British railways to the arbitrary and unmechanical

unit of the train-mile. This naturally tends to direct effort to the reduction of costs per train-mile rather than toward developments of which the immediate effect may be an increased cost per train-mile, though the final ratio of earnings to costs is improved. The ratio may be improved in two ways, firstly, by refining to the utmost possible extent the stock and plant employed to work trains of constant earning capacity; or, secondly, by the efficient utilisation of machinery and vehicles of greater earning capacity, permitting the realisation of larger receipts per train-mile."

As an example of the gain to be made by the use of wagons of large capacity, the question of mineral traffic may be taken. This traffic constitutes nearly three-fourths of the bulk, but yields little more than three-eighths of the revenue, because of the lower rates and shorter hauls. Any saving which can be effected in the tare weight of the vehicles employed in this class of traffic will permit of an equal addition to the paying load without increasing the cost of working. At the present time the average tare weight is about 39 per cent. of the gross load, so that 61 tons out of every 100 tons of full trains are paying freight. If one-third of this dead weight is saved by the introduction of wagons of increased capacity the tare is reduced to 26 per cent., which is equivalent to an advance of 21 per cent. of gross receipts. The gain is probably not so great in the carriage of general merchandise as in the mineral traffic, but it is enough to demand serious consideration.

In Mr. Twinberrow's paper a number of designs for wagons of heavy capacity are given, and the especial points demanded in construction are pointed out. The enlarged capacity must be obtained chiefly by increasing the length, and vehicles of the four-wheeled type will thus have a wheel-base so great as to occasion some difficulty on curves and turnouts. Short turntables

and tracers must also be removed and replaced with larger. Some designs are given in which it is proposed to use a cantilever extension truck, in order to avoid the objections due to length of wheelbase.

The adoption of the bogie system eliminates the objections due to sharp curvature, and is doubtless the best type for vehicles of heavy capacity, but this necessitates the removal of turntables, and the alteration of terminal plant, which includes hoists, tips, and lifts having short platforms. Designs for a variety of such wagons are given in the paper, as well as details of the changes involved in terminals, with especial reference to the transport and discharge of coal to yards, industrial establishments and ships. The successful introduction of high capacity wagons, either of the four-wheeled type, as tried on the Great Western and London & North-Western Railways, or of the eight-wheeled bogie pattern, is entirely dependent upon a satisfactory solution of the question of terminals. The substantial economies promised will doubtless justify a very considerable expenditure of capital in the alteration of existing plant; but the carrying out of such a change without interfering with the normal course of trade will demand careful consideration, and as many of the terminals where the loading and unloading are carried on are private property, it is not probable that the owners will incur the cost of alteration to suit an innovation, from which the railways will be the immediate gainers.

The Profession of Electrical Engineering.

THE inaugural address of Professor Perry before the Institution of Electrical Engineers upon the future status of the electrical engineer contains so much of general value and interest that no excuse is needed for reviewing it fully in this place. Everything Professor Perry says is so much to the point that the address is worthy of careful reading throughout, and only the salient points can be discussed here.

In the first place he puts the question: "Is the institution to continue to be a society for the advancement of knowledge in the applications of scientific principles to electrical industries, or is it to become a mere trades union?" Rapidly running over the status of other professional societies,

notably the Institution of Civil Engineers, the differences between this venerable institution and other similar bodies are shown. Particularly to be noted is the discrimination between professional engineers and those who also include contracting work in their business, and while this discrimination may be desirable in the civil engineering profession it is hardly practicable in electrical engineering. It must be admitted that manufacturers and contractors and their employees may belong to the highest ranks of the profession, and that when thus qualified they should be welcome and desirable members. It is when the engineer deteriorates into a mere imitator that he becomes a tradesman, and Professor Perry thinks that unless due care is taken this degeneration is especially to be feared in the domain of electrical engineering.

"In railway, and harbour, and river and sanitary engineering in every new job there are new difficulties to be dealt with. An engineer who designs many undertakings and sees them carried out must be a thoughtful man; he cannot help keeping himself acquainted with engineering principles, and so he is a professional man. So an architect finds that each new job requires all his experience. Every case that comes before a real physician or surgeon requires a somewhat different treatment from any old case. Every case brought before a barrister requires all the exercise of all his past experience. In every case a *profession* implies the necessity for the exercise of all one's past experience, because the work one has to do is never the same as any work one has ever done before."

When the work becomes such a routine that it does not involve the exercise of this original thought and study, it may still be good and valuable work, but it is not professional work, it becomes trade work, and as such must be so considered. This state of affairs can hardly exist with the civil engineer; the conditions of his work are too varying; he must meet and control all kinds of natural difficulties.

"Now, of all such natural difficulties the consulting or contracting electrical engineer is greatly independent. Give him a source of power and tell him what is to be done; whether he is to light a town or a building, whether with arc or incandescent

lights; whether he drives a stamp mill near a mine or a pump, or a machine tool, or a spinning frame, the electrical part of the work is carried out in much the same way. Natural conditions affect him mainly in the cost of transport of his materials and the cost of labour. He can make in an easy way the most careful calculations as to the best arrangement of his conductors and machines to give maximum economy, and except for this easy calculation his work is that of a mere tradesman. He is practically independent even of the weather. There are, indeed, some of us who grumble that this easy calculation is not made easier still, who prefer to make arithmetical guesses rather than exact calculation, because, perhaps, we like to see a little uncertainty introduced into the problem to make it more like a problem in civil engineering. I want members to see clearly that as time goes on, as our electrical engineering work gets more and more cut and dried, the man who loses the power to calculate, who loses his grip of the simple theory underlying our work, must sink more and more into the position of a mere tradesman who has no longer the right to call himself an engineer."

At the same time the question of standardisation must be considered, but care must be taken that standardisation does not become a hindrance instead of a help.

"And so, although we are all agreed that much standardisation in our contrivances and methods is absolutely necessary for our competition with other nations, we must follow the Americans in this matter and take care that it does not destroy invention. Of course, when things are ready standardised, when we have our perfect Mauser rifle, or dynamo, or locomotive, or traction engine, or electrically-driven stamp mill, a Boer can buy or even manufacture them if he has money, and he can use them as well as, or possibly better, than we can. But he is not an engineer. He uses things after the engineer has done his work upon them. A stoker, a common engine-driver, the guard of a train, these are not engineers. You must have noticed that the American engineers, who surely deserve the character of being practical idealists above all other engineers, are the men who are most im-

bued with notions of standardisation which lead to cheapness of manufacture, and they are also the men most alive to the necessity for occasional extensive scrapping of types of machinery when they become even a little antiquated."

This important subject of "scrapping" has not yet received the attention in England which it really demands, and the paper of Mr. H. F. J. Porter, in another place in this issue, gives some notable instances of the manner in which the firms which have entered in competition with Great Britain for the markets of the world have ruthlessly sacrificed tools and plant apparently fit for many years of good service.

Professor Perry discusses the question of engineering education with his usual force and ability, and, as might be expected, he strikes a blow for the proper teaching and use of mathematics. With this comes a warning for those successful practitioners who are content to settle down complacently, forgetting what little theory they did possess, and in a few years find themselves passed in the race by new and younger men possessed of later and better knowledge. That the abstract and theoretical science of to-day becomes the practice of to-morrow no one knows better than Professor Perry, and his peroration is a strong appeal for the co-operation of the institution in the scientific work of the present, for the value which it is to have for the future.

"Engineers descended from men who sneered at Cavendish and Franklin, and Volta, and Oersted and Ohm and Faraday, are you, who utilise the results of the work so sneered at and pile up fortunes in consequence of it—are you the men to sneer at and ridicule the scientific work of the present day because it seems to you useless?

"Tell us a better method of observation; give us better suggestions as to what these magnetic phenomena may mean; but the past record of scientific observation enables us to laugh at you when you say that magnetic observations may never give the world any important results. Was Nature ever so open and yet so closed about a secret as she is about this one of terrestrial magnetism? Was there ever one whose revelation promised so much? How very little

we know of electricity and magnetism! Does the mere motion of the earth, taking no account of electric changes at all, cause it to be magnetic? Almost everything is on the cards. Surely I need not appeal to your cupidity, but it is quite possible that our knowledge of this secret may enable us to trap a tremendous store of Nature's energy.

"Gentlemen, this is not a trades union, and it is not a society for the furtherance of pure scientific research, but it is a society of professional men who recognise the past services of scientific observers with gratitude and respect, and hope for greater ones in the future. And shall it be said of us that our gratitude is not greater than that of Judas, to whom, indeed, thirty pieces of silver was doubtless a large sum; that 'we have given our hearts away a sordid boon'; and that as to our future hopes we are willing to sell our birthright for a mess of pottage?"

Steam and Electric Locomotives.

THE question of the supersession of steam locomotives by electrically hauled trains has long been a subject of popular discussion, but apparently there has been but little done toward accomplishing that end. Various reasons have been assigned for the comparatively little progress which has been made in this direction, and the matter hardly appears to have been considered seriously by the great railway companies.

The paper of Mr. W. Langdon, recently read before the Institution of Electrical Engineers, examines the subject in detail, and is worthy of especial notice at the present time. Mr. Langdon declares one of the most interesting questions associated with the application of electrical energy to railway work to be the eventual suppression of the steam locomotive. At the same time he admits that there has been no material progress towards this end, although a number of powerful electric locomotives have been constructed and are at present in use upon special work. Such electric locomotives as are at present in use have been adopted for some especial reason, such as the avoidance of smoke at or near a terminal. Notable examples of this are seen in the extension of the Orleans Railway to its new terminal in Paris, and in the case of

the Baltimore & Ohio tunnel in the United States.

Because the electric locomotive has been so employed, and its employment has been attended with marked success, it does not follow, however much it may appear desirable, that in overland railways electricity will in future prove to be the element of power. Railways are commercial undertakings, in which vast sums of money have been embarked, all of which, investors expect, will produce a certain annual return. The supersession of steam by the electric locomotive thus resolves itself, primarily, into one of profit and loss. If its adoption will enable railways to be worked more economically than is the case under steam, then it will, with its attendant advantages, sooner or later, be adopted—if not by the whole, certainly by the greater portion of the railways of the country; but whatever the ulterior advantages may be, unattended by this result, its adoption will remain doubtful.

Mr. Langdon thinks we are in a position at the present time to consider this subject intelligently. We know how many pounds of steam can be obtained from a given quantity of coal, and the losses attendant upon its conversion into electricity and the subsequent transmission, distribution, and application are readily ascertainable. He therefore proceeds to tabulate the data available for the determination of the power required for the operation of steam railways and the cost, and to compare this with the computed cost of working the same roads by electric power, with favorable conclusions.

As a matter of fact, it hardly appears possible to make any such comparison, because the evolution of electric traction will probably be on such different lines from those of steam railway systems as to render the two utterly unlike. When steam railways were first started there came the inevitable comparison with the older stage coach system, and the present form of compartment railway carriage, used in England and on the Continent, bears witness to the early attempts to produce a railway carriage by placing several stage-coach bodies upon a framework supported by the running gear.

Instead of a mere replacement of the electric locomotive by an electric engine

hauling similar trains, the coming electric railway is far more likely to be a development of the independent trolley line. The train is a mechanical necessity of the conditions of steam traction, for when the whole power house is to be carried along in the form of a locomotive, with boiler, engine, fuel, attendants, water, etc., it becomes necessary to limit the number of such machines by compelling each to haul as much as possible. With the electric motor these conditions are entirely changed. The generating plant is entirely stationary, and the only portion required to be transported is the motor. This renders it possible to run frequent elements, or combinations of elements, as the traffic may dictate; and the whole train system, with the necessity for the locomotive, is open to change and modification. Much of the time now lost by waiting for trains, or by neglecting important matters in order to catch trains, may be avoided when an almost continuous succession of cars is maintained in operation between important cities. The intermittent system may be transformed into a veritable flow of passengers and merchandise, with the result that one may go to the nearest station without regard to the time and find transportation in a few minutes.

Such a change would involve the scrapping of the locomotives and rolling stock of railways conducted under the present train system, but scrapping, as Professor Perry more than hinted at in his address reviewed elsewhere, is something which must be learned if progress is to be made. The juggling with the train mile and the ton mile, so well known to railway managers in the fixing of rates and the computation of costs, would give way to a more rational system of charges based upon the actual cost of performing the service, and with the abolition of the intermittent train, and the advent of the continuous flow of traffic, the whole system of transport would be changed.

That this is at all probable in the near future it is impossible to say, for the opposition, both open and covert, of the existing railway systems is a powerful element which cannot be subject to computation. At the same time, history repeats itself, and there have been many instances in which an apparently powerful industrial organisa-

tion has been demolished by the advent of a new and more powerful successor, and unless the steam railways are prepared to do the thing themselves, they may find it done by others, when it has passed forever out of their control.

Liquid Fuel.

ALTHOUGH liquid fuel has been in use for many years in the steamships and railways of the Black and Caspian Sea district, it is only recently that supplies could be depended on at points on the various steamship routes with sufficient certainty to permit vessels to be equipped with apparatus for using liquid fuel under the boilers to the exclusion of coal. At the present time the number of places along the eastern route at which liquid fuel can be obtained has increased so enormously that it has become a question for shipowners to consider whether it is not an absolute economy to use it in preference to coal on vessels trading to the eastward.

For this reason the paper of Mr. E. L. Orde, recently presented before the North-East Coast Institution of Engineers and Shipbuilders, discussing the whole subject of liquid fuel, is timely.

Naturally, the principal question involved in the matter lies in the cost of the fuel and its calorific value as compared with coal. The effect of the fuel on the life of the boiler furnaces in which it is burnt must also be considered, as well as the immunity from danger.

Leaving aside the question of the cost of the fuel, which naturally involves commercial rather than engineering considerations, Mr. Orde proceeds to consider the practical calorific value of liquid fuel as compared with coal. This really resolves itself into the problem of the efficient combustion of the fuel, and it is to this subject that the paper is devoted. "The existing appliances designed for the purpose may be broadly divided into three:

"1st. Those in which the liquid fuel is injected into the furnace in the form of a spray by purely mechanical means.

"2. Those in which the spray is produced by the introduction of a gaseous medium.

"And 3d. Where the liquid fuel is intro-

duced into the furnace in the form of vapour."

"In the first type, the purely mechanical spray, the oil is discharged under pressure into what is commonly called a burner, which is made of such a form that the effluent jet is broken up into particles sufficiently small to burn readily at the firing point of the fuel. The full efficiency of the system can only be obtained by lining the furnace with fire-bricks, or other non-conducting material, so as to raise the furnace temperature (by preventing the absorption of heat into the boiler) until it is sufficiently high to vaporise the greater portion of the oil before it is burned. The quantity of air required to complete combustion is very largely in excess of what is chemically necessary, and the furnace space required for oxidation is large. The advantages of the system are: First, its simplicity, and, secondly, its noiselessness.

"As regards efficiency the best results that the writer has been able to find recorded show an evaporative efficiency of about 12.5 lbs. of water from and at 212° per lb. of oil. With Borneo oil this gives a fuel efficiency of 64.6 per cent.

In the second class the oil is introduced into the furnace in the form of a spray in the presence of a gaseous medium—be it steam or air. In most of these appliances a partial lining of fire brick is fitted in the furnace, and a brick bridge or baffles of various forms are built with a view of obtaining complete oxidation of the fuel. The earliest form of this apparatus consisted simply of two pipes lying one above the other, and having their ends flattened so as to spread the streams of oil and steam. Oil is admitted to the upper pipe and is allowed to drop from the orifice into the jet of steam which passes through the lower pipe and meeting the oil, breaks it up into particles sufficiently small to ignite as soon as the firing point is reached. This simple device has been improved upon by numbers of engineers, and most of the improved burners of this type take the form of concentric tubes, through which the oil and steam are passed. Adjusting arrangements are always provided, so that the supply of the two elements can be regulated at will. This type is better known than any other, and has, so far, given the best results. The

evaporative efficiency of the best burners of this type seems to be about 13—14 lbs. from and at 212° , but the supply of air required for oxidation, though smaller than that demanded by the first-class of burner, is much above what is chemically necessary. The difference between steam and air as spraying media will be touched upon hereafter. The third class of apparatus, that is, in which the fuel oil is wholly or partially vaporised, promises to give the best results.

Experiments made with these various forms of apparatus, using Borneo oil as fuel, with a calorific value of 18,831 B. T. U., show that the efficiency of liquid fuel lies in the fact that it is capable of being turned into vapours of high calorific power, and that the vaporising process does not demand a large heat expenditure. On shipboard the use of steam atomizers has been objected to because of the loss of steam and the necessity of increased evaporator surface to provide fresh water for the boilers.

With air as a spraying agent, there is, of course, no loss of fresh water, but it is questionable whether the quantity of steam used in the air compressors is not greater than that required in the burners and evaporators together. The complete combustion of petroleum spray depends, firstly, on the correct relation between the volumes of the oil and the spraying agent, and, secondly, on the velocity of the spraying agent, both of which requirements place air at a considerable disadvantage as compared with the steam. The general conclusions deduced from the investigations Mr. Orde has made are as follows:

"1. Liquid fuel of good quality, such, for instance, as Borneo oil, used in boiler furnaces, if efficiently treated, should show a reduction in consumption of about 4 per cent. as compared with coal.

"2. A reduction in bunker space of about 15 per cent. for the same weight of fuel; a reduction of about 50 per cent. for the same radius of action.

"3. A reduction in the stokehold staff of at least 50 per cent."

The advantages of liquid fuel as regards ease of manipulation, cleanliness, absence of smoke, reduced temperature of stokehold as compared with coal, increased life of boilers owing to constant temperature,

improved performance of engines owing to constant steam pressure, are all now generally conceded.

So far as the question of danger is concerned, there is no risk of explosion with a fuel oil having a flash point of over 200° F., and the only danger of fire is that due to neglect. If the burning apparatus is permitted to become dirty, or if there is much water in the oil, the intermittent action may cause difficulty, but both of these causes of trouble are readily preventable, and with reasonable care may be altogether avoided.

Pure Drinking Water.

PURE water has always been considered one of the most essential elements for health and comfort, and the procuring and distribution of a satisfactory water supply has from the earliest times constituted an important portion of the work of the engineer.

It is therefore extremely appropriate that the address of the president, Mr. James Mansergh, before the Institution of Civil Engineers, should deal with the engineering problems of pure water supply, especially as it includes that branch of the profession with which he has been most actively identified.

On the question of purity, that is, the absence from the water of any such pathogenic organism, the responsibilities of the water engineer are daily becoming more onerous and exacting. We are thus now-a-days constantly confronted with the problem as to what assistance we can hope to obtain from the chemical and bacteriological examination of water respectively.

Now, the chemical examination enables the chemist to diagnose with more or less accuracy whether and in what degree the water has been contaminated with animal or vegetable substances. The signal service rendered by these methods in detecting sewage contamination is conspicuously reflected in the diminished mortality from typhoid and cholera in this country. There are, however, many waters—often available in very large volume—which are contaminated to such a slight extent only, that they differ but very little in chemical composition from waters obtained from unimpeachable sources; and the question has

forced itself upon practical men, in view of the ever-increasing demands made by the growth of population, whether such waters must be wholly avoided or whether they cannot be rendered suitable for domestic purposes by submitting them to some simple process of purification, such as storage in large reservoirs, or filtration through fine sand.

But inasmuch as the changes effected in a water by sand filtration from a chemical point of view are quite insignificant, the nature of the services rendered by this method of treatment remained completely obscured, and were not revealed until comparatively recently, when the introduction of the now well-known bacteriological methods of water examination have enabled an entirely new interpretation to be placed upon such processes of purification. These new methods were brought to a high state of perfection some seventeen years ago by Robert Koch, and it was in the year 1885 that Percy Frankland first applied them to the investigation of the character of the purifying processes as actually practised by the London water companies. This investigation brought out the reassuring and totally unexpected fact that the processes employed were often successful in removing 98 per cent. of the bacteria present in the original water. These inquiries were also instrumental in placing these and other purification processes on a sound scientific basis. Thus among the several London companies dealing with the same unfiltered water, those companies achieved the best average result which stored the water for the longest period and filtered it at the slowest rate through the greatest depth of sand. The importance attributed to such examination is based on the supposition that most natural waters may at any time contain bacteria capable of producing disease, and we require a guarantee that any harmful forms which may be present should be prevented from reaching the consumer. This, in the present state of our knowledge, can be secured only by submitting the water to processes which effect the removal of *all* bacteria, irrespective of their harmful or harmless nature, and we therefore estimate the value of the process according to the efficiency with which it does this.

Mr. Mansergh, however, has the courage to express his doubts as the desirability of thus removing all the micro-organisms. It is common to assume that the majority are simply harmless, but it may be wiser to assume that they may be actively beneficent. The matter is not yet settled, and is under active discussion and criticism by physiologists and pathologists.

In line with the question of the procuring of pure water comes the matter of the sanitary control of the supply. Mr. Mansergh takes the occasion to assert his faith in the soundness of the principle that the purveying of water to the public should be one of the distinctive functions of the responsible sanitary authority of any district. This involves the discussion of the right to take over the ownership of private companies, and while this may seem a difficult matter to settle, it should be settled, as Mr. Mansergh suggests, not upon a basis of sympathy, but upon common sense. Just how the most equitable system of arranging such questions is to be determined is not clearly stated, but a discussion of existing cases, notably of the eight companies now supplying London, forms the closing portion of the address, and may lead to a plan applicable also to other and similar problems.

Engineering in the British Navy.

THE appearance of Rear-Admiral Melville's report, with its criticism of the results of the operation of the personnel bill in the American Navy, is made the subject for an interesting editorial in a recent issue of the *Engineer* upon the broad subject of naval engineers in general, with the implied reference to the Royal Navy, which is the real subject under discussion.

It will be remembered that the change in the American Navy was intended to amalgamate all the officers into one corps, the line and the staff to be both instructed in engineering and to be given duties in control of the engineering details of the modern ship of war. The result has been that the former engineer officers have really become line officers, and the former line officers have not become engineers, and the vessels are consequently more short-handed in the engine room than ever.

The *Engineer*, in examining this question of the deficiency of capable engineer officers, falls back upon the idea that it is no more necessary to have educated and trained engineers in the engine room of naval vessels than in those of vessels in the steam merchant marine, or in a stationary power plant ashore, and that the true solution of the matter is to place the machinery in the hands of competent machinists, paying high enough remuneration to obtain the best possible service, in lieu of rank or naval standing.

This practically corresponds to the present grade of "warrant machinists" in the United States Navy, and may be a thoroughly practical and effective solution of the problem. The engines and machinery are built by machinists, and designed by working engineers, who know little and care less about military or naval rank, and consider their calling as a business. From this class of men the navy could certainly find recruits if the pay offered were a sufficient inducement, and there is little doubt that the experiment would be successful.

In this connection, however, the thought naturally arises, if the system of training and organising naval officers fails in such a critical feature, is there not something lacking about the whole organisation? Why have naval academies at all, if the work can be as well or better done by ordinary workmen, toiling, not for the glory of the cause, but for the more business-like reward of hard cash?

Again, if this system works well for the engine room, why may it not work well for the bridge and the turret? The modern great naval gun is as much a piece of machinery as the engine in the hold, and the art of navigation is not difficult of acquirement. Perhaps the turning of the engine room over to the warrant machinist may be a pregnant precedent, fraught with possibilities not altogether grasped by those now advocating it. The modern naval officer, whether of the line or the staff, may go the way of the mediæval knight into the oblivion of history and the museum, and the men who really do the work assume the credit and carry the responsibility as well.



REVIEW OF THE CONTINENTAL PRESS

Intensified Gas Lighting.

At the time of the introduction of electric lighting it was supposed in many quarters that gas-lighting was doomed, and for a time the decline in the shares of gas companies bore out this belief. The actual result has been a stimulus to inventors, and such marked improvements in the methods of using gas as an illuminant that it has more than held its own against the formidable competition thus encountered.

Among the notable features of the Paris Exposition the extensive use of gas lighting attracted much attention, and in a recent issue of *Le Génie Civil* an extended account of the improved methods there employed is given by M. J. Laverchère.

The Compagnie Parisienne du Gaz had reserved for its display the parks and gardens of the Champs de Mars and the Trocadéro, and desired to make as brilliant a showing as possible in the face of the elaborate electric lighting of other parts of the Exposition. In order to appreciate the advance which this display indicates, M. Laverchère first gives a brief résumé of the development of gas lighting in Paris since 1877, showing the steps which have led to the present practice.

In 1877 the gas lighting was accomplished by the use of bat-wing burners, used either singly or in groups, and consuming about 140 litres of gas per carcel per hour (about 0.48 cubic feet per candle power). When, in the same year, the Jablochhoff electric candle was introduced, the gas burners were improved by using a combination of tips aided by a stronger draught, and what was considered a notable improvement followed, an illumination of 13 carcels being produced with a gas consumption of 105 litres per carcel (0.39 cubic ft. per c. p.). In 1889 the regenerative gas burner was introduced on the avenue de l'Opera and the rue de la Paix, and to a limited extent at the Exposition of that year, the consumption of gas ranging from 50 to 75

litres per carcel-hour (0.18 to 0.26 cu. ft. per c. p.), single burners consuming from 150 to 1,200 litres per hour, and giving a proportional illumination. In 1885 the incandescent mantle was invented by Dr. Auer von Welsbach, but it was not until the close of 1891 that it was manufactured in commercial form. The Welsbach burners of that date were of two sizes, the first consuming 80 litres of gas and giving a light of 4 carcels (0.073 cu. ft. per c. p.), the second requiring 120 litres of gas, and giving a light of 6 carcels; the same consumption per unit of illumination.

Since 1894 incandescent gas burners have been in use in the lighting of Paris, but during the time preceding the Exposition investigations have been conducted with a view of producing more powerful units of illumination. The result was the adoption of the Bandsept type of Welsbach burner, of 22 carcels, burning 300 litres per hour (about 0.05 cu. ft. per c. p.) under a pressure of 70 m. m. of water (2.75 inches), for the Champ de Mars, while for the park of the Trocadéro the Denayrouze burner, consuming 270 litres per hour, requiring about 20 litres per carcel (0.073 cu. ft. per c. p.) was adopted. These burners, it will be observed, represent units of 125 to more than 200 candle power, and their installation in this conspicuous manner gave opportunity for useful comparison and study. It was, therefore, decided to operate a portion of the burners with gas at the ordinary pressure, and others with intensified pressure, in order that the effects might be seen. The Bunsen burner, upon which the incandescent lamps depend for their action, provides for the admixture of the necessary quantity of air when only a moderate quantity of gas is to be burned. When, however, an increased consumption is demanded, it is necessary to furnish an increased pressure, either of air or of gas. In order to avoid the necessity of a separate system of pipes to convey air under pres-

sure, the increased pressure was given to the gas, the air being supplied as usual.

The increase in gas pressure, practically fixed at 200 m. m. (about 7.87 inches) of water, is to accomplish two objects:

1. To enable a consumption of 350 litres per hour (12.36 cubic feet) to be effected for each mantle.

2. To insure an illuminating efficiency of 9 to 10 litres per carcel (0.033 to 0.037 cu. ft. per c. p.) per hour.

Under these conditions an illumination of 35 to 38 carcels is attained by a single mantle, corresponding to 332 to 361 candle power. The compression was effected by two rotary compressors, each driven by an 8 horse-power gas engine, each set having a capacity of 1,200 cubic metres per hour.

The paper of M. Laverchère is copiously illustrated, showing the installation and operation of the plant, as well as the disposition of the burners, and much useful information as to this latest and most powerful example of intensified gas lighting is given.

The general results show that there were in use 4,619 incandescent mantles, of which nearly one-half were operated at the high pressure, consuming 1,383,200 litres of gas (48,800 cu. ft.) per hour, and giving an illuminating intensity of 91,000 carcels (about 864,500 candle power), with an efficiency of 15.2 litres per carcel (0.056 cu. ft. per c. p.).

The Strength of Boiler Shells.

It might be supposed that such an apparently simple mechanical problem as the computation of the strength of a cylindrical shell subjected to internal pressure hardly deserved especial discussion notice, but as a matter of fact there are a number of points connected with it which are too often neglected. For this reason the paper of Herr Walter Conrad in a recent issue of the *Zeitschr. des Oesterr. Ingenieur und Architekten Vereines* is worthy of note, and some of the points made by him are of interest.

Herr Conrad points out that the real difficulties in the computation of the strength of boiler shells are those which arise from the introduction of conditions which the ordinary rules do not take into account. The boiler is usually considered as a truly

cylindrical shell, of homogeneous material, of uniform thickness, free from holes, none of which conditions appears in actual practice. It is not surprising, therefore, that strength determined by computations in which so many controlling conditions are neglected must be looked upon with doubt. The usual answer is that all these points are provided for in the so-called factor of safety, or as it has sometimes been called, factor of ignorance. Herr Conrad prefers to do otherwise, and attempts to compute the weakening effect of the hole which must be cut in the plate; also the influence of hard and soft spots in the metal, and of the effect of deviations from the true cylindrical form.

Considering first the weakening effect of holes cut in the shell, Herr Conrad calls attention to the usual idea that the reduction in strength due to the cutting of the hole may be entirely offset by riveting a ring of metal around the opening, and proceeds to examine to what extent this is true. Taking the formulas of Grashof and the mathematical discussion of Holzmüller, it is shown that the circumferential stress at the edge of a hole cut in a shell is equal to double the stress in the uncut plate, and that this relation holds good independently of the diameter of the hole. This gives a simple method of computing the proper reinforcing rings, and Herr Conrad recommends the use of two rings, one within and the other without the shell, giving a much greater reinforcement than is usually considered necessary.

Defects in homogeneity, due to the presence of hard or soft spots in the metal, are necessarily difficult to subject to computation, owing to the irregular shape and indeterminate outline, and can only be properly investigated by the aid of the testing machine.

When a hole in a shell is surmounted by a dome it is desirable to be able to compute the strengthening effect of the addition, and in most cases it is wise to neglect the effect of the body of the dome, as it is of but small value, leaving only for consideration the reinforcing action of the flange, this being considered as a simple ring, and similarly computed.

Boiler shells are rarely of true cylindrical form, and hence the true stresses are cor-

respondingly difficult of precise determination. Herr Conrad discusses the effect of moderate degrees of ellipticity under various pressures and tabulates the results for practical cases. In this way he gives permissible degrees of ellipticity which do not permit a greater increase in stress than 10 per cent. above that due to cylindrical shells. These computations are based upon true ellipses, which are seldom met with in practice, and it is reserved for experimental determination to show that other deformations do not produce greater stresses.

In conclusion Herr Conrad examines the permissible limits of the factor of safety to be used in boiler computations. He concludes that for the present pressures of about 100 pounds per square inch, a factor of safety of 5 is desirable, but that with the pressure of 150 pounds, to be expected as common in the near future, a factor of 4 will be sufficient.

A further paper is promised, to contain the result of experimental investigations.

The Distribution of Steam in Compound Locomotives.

COMPOUNDING is now so generally applied to locomotives that an examination of the steam distribution is a matter of importance, and a very full discussion of the subject in a recent issue of *La Revue Technique* demands review.

In order that a good action be obtained it is now generally conceded that the admission should be more prolonged in the large cylinder than in the small one. In this manner the work of the high and low-pressure cylinders may be equalised when their relative volumes are properly proportioned. This is especially important in the case of two-cylinder compounds, and is less material in the four-cylinder compound engines, whether the motors are connected to one or two axles. With a prolonged admission in the low-pressure cylinder it is possible to attain a high speed with easy running. The compression in the high pressure cylinder is reduced, and for the same admission in the latter the weight of steam consumed is increased, and consequently a greater amount of work developed. The degree of wire-drawing in the low-pressure cylinder is also reduced, and consequently a higher economy is attained.

On the other hand, the prolongation of the admission in the low-pressure cylinder depends upon circumstances. It should be controlled by the opening of the throttle, by the degree of admission in the high-pressure cylinder, and, above all, by the speed. It must, therefore, be variable according to these varying conditions, and hence there have been, especially in France, many efforts to provide compound locomotives with valve gear permitting the admission in the high and low-pressure cylinders to be varied according to the circumstances of the work.

Naturally such a problem has been attacked in various ways. In some cases the two cylinders are provided with entirely independent valve gears, permitting the widest latitude of adjustment, but also involving the greatest degree of complication in construction and operation. In other cases the valve gears are combined and operated together, both cylinders varying the degree of admission according to the position of the lever. Another arrangement provides for a constant degree of admission, say 60 per cent. in the low-pressure cylinder, the two distributions being otherwise connected.

The arrangements in practical operation, however, may be broadly divided into two classes, based upon the modifications in the valves of the two cylinders. Either the lap on the valve of the low-pressure cylinder is reduced, and the angular advance correspondingly diminished; or, the lap may be made the same on both valves, no difference being made in the angular advance, the relative travel alone being modified.

In the discussion above referred to, the methods of employing these two methods are graphically examined, using for the purpose the well-known Zeuner diagram, and considering the Walschaert valve gear and its various modifications as best adapted for the purpose.

In many instances two distinct valve gears are not necessary, there being instead a double link and a separate valve rod for each valve, so that the valves may be operated from different parts of the link. Examples of such arrangements were seen on different engines exhibited at Vincennes during the Paris Exposition, and the action

is shown by diagrams in the original article. It is impossible to give the details of the analysis in this place, but in the original paper a number of practical examples are worked out and their application shown. The degree of flexibility thus obtained cannot fail to add to the ease and effectiveness of the locomotive, and the whole subject shows the advantages of compound engines thus equipped, in addition to the economy of compound over simple locomotives.

Continental practice has given the Walschaert gear such an exhaustive trial that its general advantages over other forms of locomotive valve gear have stood the test well, and it is a matter of surprise that it has been so little used in England and America. The ease with which it lends itself to the accomplishment of a variable steam distribution in the two cylinders of compound locomotives forms an additional recommendation to this simple and ingenious gear, and in the light of present experience in France, Germany, Belgium, and Switzerland, as emphasised by the fine engines exhibited at Paris, it is possible that the present universal judgment in favour of the ordinary link motion may be revised and modified.

Elastic Limit and Ultimate Strength.

ONE of the most important matters within the whole domain of engineering practice is a study of the properties of the materials of construction, with a view of ascertaining their strength or weakness. The whole subject of the testing of materials is recognised as of controlling importance, since the selection of a material and the proportions of the members in which it is used form fundamental elements in engineering design.

Formerly it was thought sufficient to subject a specimen of the material to be used to a stress sufficiently great to produce rupture, and then to allow a factor of safety, or determinate fraction of the breaking load as the safe working stress. Experience, however, showed that the ultimate strength did not always furnish the desired knowledge of the safe use of a material, and the importance of a knowledge of the limit of elasticity, or the stress beyond which extension ceased to be proportional to stress, began to be realised.

The question of the relation of the elastic limit to the ultimate strength of a material forms the subject of an interesting discussion in the *Zeitschrift des Vereines deutscher Ingenieure*, by Professor Mohr, of Dresden, and while the mathematical nature of his treatment prevents a presentation of his full discussion in these columns, yet his conclusions and the reasoning on which they are based may be briefly reviewed. Professor Mohr recognises that this important question cannot be answered by theoretical reasoning alone, and shows that actual tests and experiments must be used to verify the conclusions deduced from theoretical considerations.

The analytical investigation of Professor Mohr is really based upon a graphical study of the alteration in form of an elementary molecule of the body under consideration, when subjected to a stress within the elastic limit. The older hypothesis, which made the elastic limit a definite proportion of the ultimate strength, is also considered.

In discussing the data for the foundation for a modern theory, Professor Mohr considers that the limit of elasticity is that of the stress which causes internal sliding of the layers of the material upon each other, while the ultimate strength depends upon the resistance of these same layers to rupture. When the limit of elasticity or of rupture has been exceeded in any portion of a body, motion takes place in the direction of the resultant of the stresses, and the direction and magnitude of this motion is examined by the aid of graphical diagrams, in accordance with the analytical theory.

The manner in which the internal deformations actually occur may be studied by polishing the surfaces of metals which have been subjected to stresses exceeding the elastic limit, and examining the lines and figures which appear thereon. The markings are especially brought out by heating the metal to such a degree as to cause the formation of oxide, and the molecular deformation is in many instances very clearly shown. The peculiar markings which appear when the elastic limit has been passed show that there has occurred a flow or sliding of the various portions of the metal upon each other, and the intersections of the planes in which this sliding has taken

place appear as lines of flow upon the surface of the specimen.

According to the theory of Professor Mohr, the elastic limit and the ultimate resistance depend upon the stresses existing in the layers in which sliding and rupture occur, and the resultant of these forces enables the relation between the two limits to be determined.

In the case of a round rod pulled in the testing machine, the reduction of cross-section shows very clearly the action of opposing forces, acting to extend the length and at the same time to reduce the diameter of the extended portion. We here have axial and radial forces acting at the same time upon the material, and the nature of the fracture shows the manner in which the material responded. On the end of the fractured piece are seen the radial lines in the direction in which the rupture took place, while the axial markings show the sliding which occurred. As these relations vary under different conditions, it is apparently erroneous to assume directly that the elastic limit bears a definite relation to the ultimate strength. The immediate conclusion is that the conditions under which the stresses are applied should be taken into account, and that, whenever possible, the material should be tested under conditions analogous to those under which it is to be used.

Professor Mohr refers to the investigations of Mr. J. J. Guest, in England, as sustaining his views, although he had no knowledge of these at the time of his own researches, and the whole subject appears to be opened up anew in a manner which may lead to a more intelligent study of the strength of materials of construction.

Power Gas Development.

THE continued interest in the development in the question of the utilisation of lean gases produced in metallurgical operations as a source of power is shown in the attention which is given to the subject in the technical press, especially in Germany and in Belgium. We have in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure*, a publication of the paper recently presented before the society by Herr A. Wagener, followed by a further discussion of the subject by the same engineer

in the pages of *Stahl und Eisen*, giving the latest developments of practice in an interesting manner.

Herr Wagener credits Mr. Thwaite with the first attempts to use furnace gases in internal combustion motors, citing the experiments in the autumn of 1894, these being soon followed by the work of the Hörde Iron Works in 1895, and by numerous installations in various parts of Europe. The existing forms of gas engine at the time of the proposal to use furnace gases were designed for the use of illuminating gas, a fuel of 5 to 6 times the calorific power of the lean gas discharged from blast furnaces, and in most cases the engines were of comparatively small size. Since the first application of engines at iron works in the production of the blast, it has been necessary to design large engines, from 600 to 1,000 horse power, and to so proportion them as to be adapted for the lean gas of the furnaces as their fuel.

Herr Wagener gives special attention to the engines of the Oechelhäuser type, and illustrates its construction by detailed drawings, showing the applicability of these large gas engines for direct connection to blowing cylinders and also to the driving of electric generators. Owing to the large surplus of power which may be generated by the gas from a furnace, over and above that required for the production of the blast, it is especially desirable that electric driving be introduced, since practically all the power required, as well as the lighting, may thus be obtained from the use of the gases, without the necessity of employing steam boilers and engines.

Although Herr Wagener devotes the greater part of his discussion to the recent installations of the Oechelhäuser engine, he calls attention to the general development in the building of large gas engines resulting from the appreciation in recent years of the economy of this type of motor, and its adaptability to a fuel otherwise wasted. Not only the original gas engine works of Otto, at Deutz, but also the establishments of Körting, the Berlin-Anhalt Works, the Aschersleben Works, the Augsburg Works, the Cockerill Works, and a number of others, have undertaken the regular manufacture of large gas engines adapted for use with lean gas. The pre-

diction of a prominent German engineer, made only a few years ago, that the gas engine builders would not be able to supply the machines to utilise the vast volumes of furnace gas then thrown to waste, has fallen so far short of the fact that it has been demonstrated that motors of this type are to be reckoned with as a standard article of manufacture. As a matter of fact, a number of large steam-engine building works have already undertaken the construction of gas engines, and others are preparing to add a line of such motors to their product.

One of the important results of the display of gas engines at the Paris Exposition is the realisation on the part of engine builders that there is nothing mysterious or difficult about the construction of such motors. As a matter of fact, there is less complication and difficulty than with the more highly organised forms of steam engine, and as the fluid with which they are operated is permanent, as opposed to the condensable steam, the thermal economy is much less readily affected by variations in design than with the steam engine.

In view of the fact that the fundamental principles of gas engine construction are open to the world, and also taking into consideration the growing practical interest in such motors, a very rapid development in this branch of industry may be predicted.

It is of especial interest to note that the development of internal combustion motors at the present time is mainly directed toward two extremes; the large motors, of 200 or 500 horse power, and upwards, and the very small motors, of 2 to 10 horse power, for motor vehicles. With the exception of minor details of construction, due to the peculiar conditions of operation, the construction of both classes is identical, and, furthermore, the thermal economy of the small motors is nearly as high as that of the larger ones, the great obstacle to economy of small steam engines, internal condensation, being absent in motors operating with permanent gases.

The Work on the Simplon Tunnel.

FROM time to time the project of a tunnel at the Simplon Pass between northern Italy and western Switzerland has been dis-

cussed in these columns, and as the progress of the work has been recorded in current technical literature the accounts have here been reviewed. The exhibit of the work made at the Paris Exposition has been made the occasion of a very complete review of the whole undertaking by M. A. Dumas, in a recent issue of *Le Génie Civil*, and the magnitude of the work renders further notice at this time desirable.

The massive ridge of the Alps known as the Simplon has long obstructed travel by rail between Italy and western Switzerland, although the present highway road was constructed over the pass by Napoleon I. between 1800 and 1806, at a cost of 18,000,000 francs. For nearly fifty years the idea of piercing the mountains by a tunnel had been considered, and a number of plans proposed and discussed, but the cost of the work rendered the commencement a matter for repeated delay. The growth of traffic, and the gain in distance by creating this connection in the route from Paris to Suez and in general between Italy and the North Sea coast, however, has changed conditions to such an extent that the advantages of the tunnel became too evident to be neglected, and the work has now been under way for more than two years.

Much of the preliminary work which preceded the actual commencement of operations was devoted to the financial development of the work, subsidies being obtained from both the Swiss and Italian governments by the Jura-Simplon Railway, and a concession was secured for a period of 99 years, the total cost being estimated at 69,500,000 francs.

As already explained in these columns, the plan for the tunnel differs from the existing Alpine tunnels in that two bores, each for a single track, are planned in place of one double track tunnel. This idea possesses a number of advantages. In the first place, the quantity of excavation required is less, even if the work were all done at one time, but the great feature of the system is that it enables one tunnel to be completed first, while the other may be added when the traffic shall demand it. In the meantime a small passage is to be pierced on the line of the second tunnel, and used for the purpose of drainage and ventilation of the completed section, this passage being con-

nected by cross openings to the first tunnel at regular intervals. The enlargement of the second tunnel to the full size may then be made at any subsequent time without interfering with traffic on the completed part.

In length the Simplon tunnel exceeds any of its predecessors, the principal Alpine tunnels being as follows:

	Length.	Altitude.
Mont Cenis...	12,849 metres	2,949 metres
St. Gothard...	14,984 "	2,861 "
Arlberg	10,240 "	2,030 "
Simplon	19,731 "	2,840 "

An important feature in connection with the work lies in the abundant supply of water under pressure, which renders the employment of hydraulic drills practicable. The water used for the purpose is taken from the Rhone, being brought a distance of $4\frac{1}{2}$ kilometres through an aqueduct of reinforced cement, constructed on the Hennebique system, the delivery being 5 cubic metres per second under a head of 44.6 metres, and furnishing 2,230 effective horse power on the shafts of the turbines.

Owing to the possession of ample power, and also because of the use of modern high explosives, the time for the completion of the tunnel is expected to be proportionally much shorter than was the case of the earlier Alpine tunnels. The schedule laid out for the work contemplates the completion of the first portion, giving a single-track rail communication between Brieg and Iselle, in a period of five years and nine months from the commencement of the work. The rate of progress up to the middle of 1900 was very satisfactory in this respect, having been kept fully up to the pace necessary for the completion of the tunnel by the middle of the year 1904.

An interesting feature of the work is the high temperature encountered in the mass of the mountains. A steady rise was experienced on both sides of the Alps, the thermometer rising from 16.4° C. at 900 metres penetration on the Swiss side, to 20.4° C. at a penetration of 2,000 metres, while at the same penetration on the Italian side the thermometer reached 28.4° C., or more than 83° F. Under such conditions the value of the auxiliary tunnel for the delivery of cool, fresh air directly at the headings is great, and without such a system

the time for the completion of the tunnel would have been greatly prolonged by reason of the unexpectedly high temperatures encountered.

With the completion of the Simplon tunnel, direct rail communication will be effected through from Geneva to Milan. The distance between Calais and Milan, which is 1,095 kilometres by the Mont Cenis route, and 1,070 kilometres by way of the St. Gothard, will not be more than 942 kilometres by the Simplon. The Ostend-Simplon-Milan route will be 95 kilometres shorter than the Ostend-Gothard Milan route.

Improvements in Testing Materials.

SOME time ago we referred in these columns to the method, proposed by M. Ch. Frémont, for examining the resistance of materials of construction, notably iron and steel, by studying the deformations of lines inscribed upon the surface of the material before subjection to stress.

M. Frémont has made this method the subject of an elaborate paper presented before the Congress for Testing Materials recently held at Paris, and from a publication of this paper in a recent issue of the *Revue de Mécanique* some abstracts are here made.

In practical work there are three elements of the strength of a material concerning which information is desired. 1, the limit of elasticity, beyond which the deformity of the test piece remains set; 2, the ultimate resistance of the specimen; 3, the total elongation of the test piece up to the moment of rupture. Of these the elastic limit is not always readily determined with precision, even upon testing machines provided with recording apparatus. Annealed steel or iron will give a well-defined limit when the same material, when hammered or drawn, furnishes curves upon which the desired point can only be arbitrarily selected. M. Frémont gives a number of examples of tests made upon pieces of the same material using different machines, the results showing clearly the variations which are experienced. The cost of such methods of test, involving, as they do, elaborate and expensive machines, the expenditure of much time in the preparation of specimens and conduct of tests, and delay in obtaining

results, led M. Frémont to devise a simpler method, concerning which he gives much interesting information in his paper.

After a careful consideration of the matter M. Frémont decided to adopt the bending test as revealing at the same time the effects of tensile and compression stresses, as at the same time being one readily and conveniently applied, using for this purpose a simple form of punching press.

As already indicated, the method of M. Frémont includes the tracing upon each side of the test piece of fine parallel lines, spaced one millimetre apart, and he has devised a simple and convenient apparatus for the preparation of the specimens. The test pieces themselves are much smaller than is necessary with the usual methods, the standard piece for the Frémont process being only 25 millimetres long, and 10 by 8 millimetres in cross section. The small size of the test piece renders it possible to take many specimens from various parts of a given sample of material, and in many cases the fragments produced in the working of an object will furnish pieces available for test. The machine in which these pieces are tested is made with a simple recording device, the force being measured by the elasticity of the machine itself, each machine being calibrated independently. From the diagram produced by the machine the actual strength of the specimen is found, while from an inspection of the lines under the microscope the important data concerning the manner of yielding are seen. In addition to the application of the stress by the direct bending action of the press, M. Frémont has extended his method to include drop tests, the general principle being the same. The drop tests, (being intended to produce rupture, are made upon test pieces which are nicked in order to localise the

rupture, a special form of caliper being made to insure uniformity in the depth of nicking and render the results uniformly comparable.

As a practical example of the method as applied in actual work, M. Frémont gives the detailed account of the tests of a rail, showing how the test pieces were cut to represent practically every portion of the rail section. A metallographic study of the same section was also made and the appearance of the etched section given to enable the comparison between the stress tests and the physical structure to be made.

For the details of the application of the method the reader must refer to the original paper, which in itself contains so much that is valuable and interesting as to demand the attention of the engineer in any case. The really important point brought out in the whole is the fact that a method of test to be practically useful must be simple enough to be readily applied, so that it may be used constantly upon work in the course of construction. In this way alone can sufficient information be had about the character of the material put into a structure to enable the engineer to proceed with confidence as to the actual strength of the whole structure. Isolated tests made in such a manner that the results are not available until after the work has been put upon the material, or until after the whole structure has been nearly completed, are of but small value for the especial case under consideration, and are often unavailable for subsequent use. What is really needed is some current and continuous guide for the engineer in charge so that he may not be obliged to feel his way in the dark, and for this purpose there appears to be nothing so well adapted as the method devised by M. Frémont.



REVIEW OF THE AMERICAN PRESS



The Development of the Steam Turbine.

AMONG the papers presented at the recent meeting of the American Society of Mechanical Engineers may be noted an exhaustive examination of the history, development, and present status of the steam turbine, this being prepared by Professor R. H. Thurston, past president of the society.

After calling attention to the fact that the two modern forms of steam turbine, the Parsons and the De Laval, are practically identical in principle respectively with the reaction wheel of Hero (120 B. C.), and the steam wheel of Branca (A. D. 1629), Professor Thurston proceeds to show the high theoretical efficiency of such machines.

"The steam turbine is, in essence, economical through its simplicity and the directness which distinguishes its method of thermodynamic losses are due, as in other subject to small loss of mechanical efficiency through friction of journals, it having but a single pair of rubbing parts, bearings of small diameter, although of enormous speed of revolution, and it is entirely free from the great source of waste in the reciprocating engine, that internal variation of temperature of metal-surfaces which, ranging from the temperature of prime steam to that of the exhaust, nearly produces wastes amounting to from 10 per cent. to sometimes 50 and more of the heat, steam and fuel supplied. In the steam-turbine, the internal surfaces, while it is in steady motion, are, in all parts, at a constant temperature, and that is the temperature, practically, of the steam in contact with the element of surface. Its only thermal loss is by conduction and radiation, and that may be made very small. Its thermodynamic losses are due, as in other steam engines, to incomplete expansion within the wheel and discharge of the fluid with considerable energy of mechanical motion through malproportion, maladjustment or lack of adaptation of the speed

of discharging orifice to the velocity of the expanding, rejected fluid in such manner as to reduce its velocity of rejection, into the air or the condenser, to a minimum."

The performance of the "Turbina," fitted with engines of the Parsons type, at her trials in 1894, giving speeds of more than 32 knots, with steam consumptions under 20 pounds of steam per horse-power, called general attention to the possibilities of the steam turbine, and the "Viper," the successor of the "Turbina," with its trial speed of 37 knots, or more than 43 miles per hour, has confirmed the correctness of the principles on which both boat and motive power were designed.

"Steam turbines of great size and power are likely soon to be produced for many purposes, now that their performance has been found so satisfactory, and especially for torpedo-boat work, and their construction on a large scale will enable the engineer promptly to settle many questions of interest which the earlier work on small machines could not fully solve. It would seem that, as with the gas engines, the larger the scale of operation, the simpler the problems of design and construction, and the easier the approximate of the real to the ideal in perfecting the system of energy conversion. Large turbines are comparatively low in speed of revolution, and it is considered that it would be entirely practicable to build an ocean steamer of large size, driven by turbines of 30,000 or 40,000 high pressure, or more if needed, at speeds of revolution as low as 400 per minute or lower, employing four shafts and eight screws, requiring minimum steam and fuel for their work, while economizing enormously in space and weight. There would be no vibration or noise annoying to passengers, and their simplicity of construction and freedom from the multitudinous bearings of the now usual construction of engine would give insurance against either

breakdown or minor troubles and delays from heated journals, leakages about the engine, or other annoyances and expenses inseparable from the reciprocating machine. Steam pressures can be adopted at the maximum practicable with the steam-boilers of contemporary practice, whatever the limit may be. That limit will thenceforward always be found at the boiler."

In discussing the general theory of the steam turbine, Professor Thurston shows that such machines operate according to the Rankine or Clausius cycle, and gives a complete analysis of the ideal case for such a cycle, there being no compression. He thus shows that the steam turbine corresponds in actual operation more closely to its ideal cycle than any other form of motor, and is in fact the steam engine of maximum simplicity and highest thermal efficiency.

The length of Professor Thurston's paper precludes further abstract except so far as to give the conclusions deduced from his exhaustive examination of the whole subject.

These conclusions are as follows:

1. The steam-turbine thermodynamically approximates in its real form more closely to the ideal than does any other type of heat-motor. Its cycle lacks only the introduction of the Carnot compression.

2. It is entirely free from that waste, which in the real steam engine of common type constitutes usually, if not invariably, the most important of its extra thermodynamic losses.

3. It is peculiarly well fitted for use with those very high steam pressures, as we now regard them, which must ultimately probably be resorted to by the engineer designing heat engines, in his endeavor to further improve the efficiency of that class of motors.

4. It is only limited in speed of rotation by the strength of its materials of construction.

5. It is especially suitable for use with superheated steam, it having no rubbing parts on which lubrication may be difficult in presence of superheated steam, and the limit to the superheat, so far as the motor is concerned, being only found at that point at which increased temperature of metal produces reduction of tenacity in objection-

able amount. That limit, not as in earlier days of lubrication with animal oils, and still with other engines, is fixed with this machine at the boiler.

6. As to its operation, it is obvious that friction is peculiarly active for evil in this motor, and that small diameters of journal, freedom from contact of part with part, except as absolutely required by the construction, and minimizing fluid friction by superheating steam, and by securing as complete removal of the atmosphere, air of vapor from about the revolving wheel as practicable, must be carefully sought, in order that the mechanical efficiency of the machine shall be made a maximum.

7. The wastes of the steam-turbine are all extra thermodynamic; the loss due, the absence of adiabatic recompression excepted. They consist of (1) journal-friction, which is made a minimum by the use of a flooded bearing and a light ungent; (2) fluid friction between disk and leakage, steam, or suspended moisture in the jet, which may be made a minimum by superheating, and between the disk and its enclosing atmosphere of vapor, which may be minimized by the employment of a good condenser; (3) loss of heat and of steam by leakage, which may be reduced to a minimum by durable material, fine workmanship, and close fits; (4) waste by incomplete expansion, which may be reduced to a limit determined by the finance of the case, by the resultant increase of friction and of cost due the necessary enlargement of the turbine; and, finally (5), thermodynamic waste by failure to secure that complete adiabatic recompression of the fluid which is necessary to convert the Rankine-Clausius' cycle into that of Carnot. The latter is a peculiarly difficult matter with the steam-turbine, since it probably necessarily involves the employment of a separate vapor-compression pump of special character, and an amount of added work and cost which may introduce losses more than compensating its gains.

The Coaling of Warships at Sea.

ABOUT a year ago there was presented before the Society of Naval Architects and Marine Engineers a paper by Mr. Spencer Miller upon the subject of the

problem of coaling vessels at sea, this paper being followed by another by the same author in the pages of this magazine for February, 1900, giving a detailed account of the work of the writer in solving this important problem. We now have a further paper by the same engineer presented before the same society, giving an account of the more recent experience in the solution of the problem, with comments upon the system employed by various naval experts.

As described in Mr. Miller's paper, above referred to, the main element in the problem lies in the maintenance of a suitable tension upon the cableway connecting the collier and the warship, it being understood that the conditions of warfare render it undesirable for vessels to leave their posts to take coal, while it is impracticable for colliers to be brought alongside except in harbor. The device employed by Mr. Miller involves the towing by one vessel of the other, a conveying cableway extending between the two vessels for the transfer of the coal from the collier to the warship. The plunging and pitching of the vessels in the sea has always rendered schemes of this nature impracticable until the device of a slipping winding drum was introduced, this taking up the slack and meeting the increased tension in a very satisfactory manner with the varying positions of the vessels. In connection with the two lines of the cableway there was added a third line connected with a sea anchor to support the carriage when empty on its return to the collier, but it has since been proposed to replace this with a slipping-drum tension-engine.

The paper is mainly devoted to an account of the trials in coaling the U. S. S. "Massachusetts" at sea, under the inspection of a trial board of United States naval officers, the tests being such as were prescribed by the Navy Department, in order to determine whether or no the device should be accepted by the government:

"The apparatus had five trials. On the first day adjustments were made and 9 loads only were sent over. On the second day more adjustments were made, and a run of 38 loads in 38 minutes and 40 seconds was suddenly terminated through the lack of skill on the part of the operator,

who allowed all the rope to be coiled on the forward drum. This slipped the clip on the end of the rope through the other drum, and the rope fell into the sea. No damage was done, no one hurt, and the only penalty of such an accident was an hour's delay in rigging up again. On the third day, in one hour the apparatus transferred about 22 tons, and the work would have been continued longer but for lack of sufficient crew to fill the bags.

"The Navy Department then ordered an endurance test of not less than four hours' duration, and a rough weather trial as well. Twenty men were added to the crew to fill the coal bags.

"Between the third and fourth trials some trifling alterations were made. The fourth trial lasted four hours. Seventy-five tons were handled in 3 hours and 43 minutes. The water was smooth, with a ground swell. In the fifth test—the rough-weather trial—80 trips were made in 80 minutes. The performance could have been continued for an indefinite time, but the board being satisfied there was no object in going further.

"In the rough-weather trial, one hour and a half was consumed in securing the tow line and setting up the apparatus.

"The boats steered at first head-on to the sea. The forecastle of the 'Massachusetts' was washed at every plunge, and no coal could have been delivered there even if desired. A little more than 20 tons were handled in an hour. The course was then changed, quartering on the sea, and the results were the same. Then the boats steered in the trough of the sea, and a rolling of 7 degrees did not affect the working. The speed was maintained at about 5 knots. The 'Massachusetts' burned $3\frac{1}{2}$ tons of coal per hour during the trial."

The result of the trials was the acceptance of the apparatus by the government, and it is now proposed to make the device a feature of fleets cruising away from convenient coaling stations. A prominent Vice-Admiral of the Royal Navy, in discussing the device, suggested that if its operation could be carried on at a ten-knot speed, and forty tons per hour capacity, its use should become universal. It was also suggested that all the operating machinery should be placed on the warship,

so that coal might be taken from any collier. The recommendations are entirely practicable, and there is no good reason why they may not be carried out. The importance of the subject of coaling at sea can hardly be overrated. Coal is the real essential of modern naval warfare, and no fleet can carry on operations for a prolonged time away from coaling stations without some satisfactory means of carrying coal to the enemy's coast and transferring the fuel from the colliers to the warships at any point and under any reasonable weather conditions.

A modern fleet accompanied by an auxiliary fleet of colliers and equipped with cableways for transfer of coal at sea is in a position to act, in fact, as if the first line of home defence was the enemy's coast, while without such apparatus this position would be untenable.

The introduction of modern mechanical devices in this fundamental element of naval warfare is another example of the manner in which the civilian engineer meets and solves problems which have confronted the naval engineer for long years, and shows the truth of the idea that the greatest improvements in any profession often come from those outside of its assumed limits.

Rebuilding the Kinzua Viaduct.

NEARLY twenty years ago the Kinzua viaduct, on the Erie Railroad, was considered one of the characteristic examples of American engineering construction, and its bold design and effective execution attracted much attention on both sides of the Atlantic. Notwithstanding the fact that the old viaduct remained in good condition up to the present time, the increase in the weight of locomotives and rolling stock rendered it advisable to provide additional strength, so that the whole structure has been entirely rebuilt, according to modern practice. The work was done by the Elmira Bridge Company, from the designs of Mr. C. R. Grimm, who describes the new structure very fully in a paper presented before the American Society of Civil Engineers.

The viaduct spans a deep valley, and is 2,053 feet long, the railway being carried on twenty towers varying in height from

30 feet to 285 feet, and in the old structure these towers were light as to the main members, and well counterbraced to resist lateral wind stresses.

In preparing the plans for the new design, Mr. Grimm decided to dispense with any secondary bracing, by building the wind bracing strong enough to take care of itself. The tower legs, being the real supporters of the railway, he also increased in dimensions, so that they stand out boldly, instead of looking rather slender and more or less overshadowed by a mass of bracings. This construction involved a considerable increase in the height of the stories, fewer members to build, a quicker erection, and a great reduction in field riveting. As shown in the drawings and photographs accompanying Mr. Grimm's paper, the towers are made of lattice members, both as to up-rights and diagonals, except the top, which is composed of solid plates. The notable thing about these new towers is the height of the stories, this taken transversely being 62 feet, an increase of about 100 per cent. over that which is common in viaducts, while the height on the longitudinal faces is 31 feet. The dimensions, sizes, and details of all the towers are the same from their tops downward, or in other words, the dimensions, sizes, etc., for any tower are obtained from the tallest tower by shortening the same from the bottom upward.

Mr. Grimm goes quite fully into the analytical computations by which the towers were proportioned, this portion of his paper forming a valuable contribution to the study of wind stresses and their practical analysis for such framed structures. This is the more valuable since the stresses in frames of this kind have not before been analytically discussed, and hence the completeness of the study should be most acceptable to bridge engineers.

The work of erection of the viaduct was carried on simultaneously from each end by two travelers. These carried the hoisting machinery and spanned a clear space of 160 feet, having an old tower in the middle. In this position the old tower was taken apart, its material hoisted up and loaded on cars and run out to the shore end of the structure, and a new tower assembled. The work of removing the old viaduct and erecting the new one consumed four

months, with a force of about 120 men at 10 hours a day.

Apart from the direct interest in the work as a notable piece of bridge engineering, this construction of the Kinzua viaduct is a good example of the manner in which structures otherwise excellent become obsolete in a period far within their natural life. The old viaduct might, with reasonable care, have lasted many years longer, but it had to be scrapped and replaced by an entirely new structure, not for any defect of its own, but simply because the increased service demanded a heavier bridge. Whether it is better to follow this policy of replacement rather than to attempt to build for many generations ahead, may be a matter for discussion, but in many cases there is no choice.

The Experimental Basin at Washington.

EVER since the classical researches of Froude it has been realized by engineers and naval architects that the only way to ascertain accurately the behavior of proposed designs for vessels is by the use of models in the trial tank. Such tanks have been constructed by several private establishments, the most recent among them being the new one recently built by the Vulcan shipbuilding works at Stettin, but the most complete government tank is that of the United States at the Washington Navy Yard. This basin was fully described more than a year ago, at the time of its completion, by its designer, Naval Constructor D. W. Taylor, U. S. N., and reviewed in these columns at that time, and now we have from the same able pen an account of the experience had with it in actual service, this paper being presented at the recent convention of the Society of Naval Architects and Marine Engineers.

In view of the fact that a large sum is to be expended for the construction of additional vessels for the United States Navy, the importance of the possession of this testing basin cannot be over-estimated, and some brief description of it is desirable, supplementing the account given in these columns in the issue for August, 1899. There are two noteworthy features about the basin, one being its large size; length, 470 feet; width, 42 feet 8 inches; main section, 14 feet 8 inches deep; the other being

that with the tank, models of 20 feet in length are tested, instead of the 12 foot size customary in the European basins. It is worthy of note that in the Washington tank wooden models are used, instead of those of paraffine, and in Mr. Taylor's paper the ingenious machinery for shaping the models is described at length.

The models are drawn through the tank by a traveling bridge, spanning the basin and operated by electric power, and upon the bridge is placed the recording apparatus for measuring the resistance and other data to be determined. The copious illustrations and elaborate working drawings accompanying Mr. Taylor's paper enable all questions as to construction and operation of the basin to be fully answered, and to them the interested reader is referred. At the present time the especial subject of interest is the account of the trials which have already been made, particularly with models of vessels already in service, the actual performance of which is well known.

In testing models of men-of-war, it is the usual practice at Washington to determine five resistance curves, each extending somewhat beyond the speed corresponding to the maximum speed of the vessel. These curves are made (1) at normal displacement, (2) with trim changed 4 inches by the head, (3) with trim changed 4 inches by the stern, (4) with displacement 10 per cent. lighter than normal, and (5) with displacement 10 per cent. heavier than normal.

As an example of the results obtained by such a series of tests, the curves for the U. S. S. "Yorktown" are given, and with these are also given the curves showing the actual changes in bow and stern levels of the model of the "Yorktown" at normal displacement. The peculiar characteristics of these curves are naturally best obtained by inspection, but may briefly be described here. Whenever the model is under way there is a tendency to settle, both bow and stern settling alike at low speeds, while as the speed increases the bow first settles and then begins to rise again. If the speed is pushed the bow rises even above its original level, the stern at the same time developing a tendency to sink. This settling does not imply a greater immersion in the water, as the

water level around the model is disturbed by its passage.

The speed curves of the "Yorktown" are given by themselves, and are also included in a general series of typical curves based upon experiments made with a number of models. All these show in general the same characteristics. At the portion of the curves between the speed of four and five knots for the models, corresponding to speeds of 16 to 20 knots for the full-sized vessels, certain peculiar humps form in the curves, these being most pronounced in the curves obtained from narrow, deep models, while they die away and appear only as flat spots for broad, shallow models. These humps are due to the interference between the bow and stern wave systems. For a fine model of low displacement, such as a model of a destroyer, this hump almost disappears, while for a battleship model the hump is very pronounced between four and five knots, the resistance curve becoming very steep after the 4 knot speed is passed.

The value of the trial basin is especially seen in the investigation of the tentative models made for the five vessels of the Georgia class, these being the most powerful battleships and the largest vessels yet undertaken by the United States government. The results obtained with these models show conclusively the direct practical value of model experiments. Taking two models for these vessels, the curves for which are given, it is shown that an increase of length, giving nearly 4 per cent. greater displacement, enables the desired speed of 19 knots to be obtained with 2,000 less horse power—19,000 h. p., as against 21,000 h. p.!

The use of the trial tank, which cost about \$100,000, will enable the complete and satisfactory determination of such vital features as form, length, and powering for the five new battleships now under design, and which are estimated to cost some thirty millions of dollars, and for this single purpose alone, the value of the investment is apparent. The basin is also available for the testing of private models whenever it can be so employed without interfering with government work, and hence will doubtless be a great benefit to shipbuilders generally.

It is a matter of especial interest to note

the freedom with which a government officer is permitted, as in this paper, to give to the world information and data which in other countries would be scrupulously guarded as state secrets, a policy which many will contrast with the secretive practice of nearly every other government in the world.

The Water-Jet in Engineering Construction.

ALTHOUGH the water-jet is an old device in connection with engineering work there appears nowhere so complete an account of its use as is found in a recent paper presented before the Engineers' Club of Philadelphia by Mr. L. Y. Schermerhorn.

"The general action of the water-jet may be illustrated by its operation in sinking ordinary wooden piles. The pile, properly held in position in the leaders of a pile-driver, is lowered upon the bottom, and the water-jet placed in operation close to the lower end of the pile; whereupon the pile, either through its own weight or aided by that of the pile hammer, lowered upon the head of the pile, rapidly sinks, with the water-jet, into the semi-fluid mass of sand which the water-jet has produced. All variations in the use of the water-jet for sinking piles are modifications of the action just described."

According to Mr. Schermerhorn, the earliest use of this method was made at Decrow's Point, Matagorda Bay, Texas, being suggested by Captain George B. McClellan, at that time chief engineer of the Department of Texas. A list of many important applications since that time in all parts of the world is given, with many details of the success which attended its use under difficult conditions.

Under certain circumstances, however, difficulties are encountered.

The experiments undertaken in connection with the work upon the improvement of the Mississippi and Missouri rivers showed that the water-jet cannot be relied upon to give satisfactory results in material containing a large percentage of gravel; that it should be capable of such concentration of its force as will permit the stream to be delivered through a nozzle not more than 1½ inches in diameter, and frequently somewhat less, and with pump power capable of giving a nozzle pressure of from 75

to 150 pounds per square inch, while the presence of gravel required the smaller nozzle and higher pressure.

"Various suggestions and experiments have been made relative to securing the action of the water-jet on a line coincident with the vertical axis of the pile, and while such efforts have been ingenious, experience has demonstrated that they did not secure greater efficiency than that obtained by placing the jet alongside of the pile in the manner previously described."

From the very nature of the jet it is evident that its action depends upon the high velocity and pressure of the stream of water, and this again is dependent upon the power and capacity of the pumps. Mr. Schermerhorn points out that it is a very common error to provide pumps of insufficient capacity, and in nearly every application in the early history of the process the efficiency would have been largely increased if the pumps and hose had been of much greater capacity. The tremendous power of the jets used in California in hydraulic mining is evidence of the effectiveness of such a method of penetrating material, and if such jets were intelligently applied to engineering work a like efficiency could doubtless be secured.

The hydraulic jet has been effectively used for grading on the Mississippi and Missouri rivers, and under favorable conditions in this work 6,000 cubic yards of material have been handled in a day of twelve hours. In this case material which cost from 10 to 12 cents a cubic yard when removed by shovels and scrapers, was handled by the jet at a cost of from 1.1 to 1.2 cents per yard.

The paper will doubtless call attention to a powerful method which has hardly been employed to the extent legitimately possible.

The Electric Measurement of Power.

At the recent convention of the American Society of Mechanical Engineers an interesting paper was presented by Professor Forrest R. Jones upon the subject of power and light for the machine shop and foundry. In discussing the selection of motors for driving various machine tools, the paper describes some measurements which show conclusively how useful the electrical

method of measurement may be made, and incidentally gives some useful information as to the amount of power required for various mechanical operations. The tools investigated included lathes and similar tools, planers, involving a reciprocating motion with a reversal of nearly every part of the machines, electric hoists and cranes, and many minor tools. The power required by various tools naturally varied with the nature of the work, and the tests were made as a rule to determine the maximum, in order that sufficient motor capacity might be provided. At the same time it was made apparent that other considerations besides the useful work performed in many cases affected the power consumed, and showed the fallacy of measuring the power consumed by a tool by the amount of metal removed from the piece under the tool. In the case of lathes the tests were made upon them when polishing cylindrical pieces, the polishing laps gripping the work tightly, almost after the manner of a brake. Under these conditions the power required to drive two lathes, one of 48 and the other 36 inch swing, was a little over seven horse power.

In the case of a planing machine it was demonstrated that the greatest amount of power was required, not under the forward cutting motion, but during the return stroke, the maximum being indicated at the moment of reversal. In the case of a 120 inch planer, with 22 foot table, it was shown that the amount of power required for reversing was about 1.8 times that necessary for its average running at a time when not reversing. When this machine and another one 72 inches by 25 feet were both reversing at the same time, the power required at the moment of reversal ran up to 60 horse power. A similar action was exhibited by several planers, the greatest amount of power being required at the time of reversal from cutting to return stroke, this being doubtless due to the increase of speed at that time.

Tests of traveling cranes showed naturally a great variation in the demand for power under different conditions. As might be expected, the greatest amount of power was demanded during general manœuvring, when two or more functions were started at the same time. A 30 ton traveling crane, manœuvring with a 20 ton load, demanded

60 to 100 h. p., while hoisting 20 tons uniformly at 10 feet per minute required about 33 h. p. of electrical energy. As this latter operation corresponds to only about 12 h. p. of work, the mechanical efficiency of this particular machine appears to have been about 36 per cent.

Another revelation made by the electric testing of power consumption was that of an elevator, ordinarily driven mechanically from the line shaft by means of worm and worm-wheel connected to the elevator winding drum. Ordinarily this elevator should not have required more than 5 horse power to operate it, whereas it actually required from 2.5 up to nearly 22 horse power in going up without load, and 10 to 0.1 horse power in going down. Although the worm gearing appeared to be all right and was well lubricated, this great variation in power evidently pointed to defective adjustment.

These and various other measurements, although primarily intended to be used for the determination of the proper motors for use in installing electric power in a given establishment, afford an instructive lesson in the usefulness of the electrical method of measuring power. When machine tools are driven by independent motors, a glance at the volt and ampere meters will enable the fluctuations to be read off. This advantage, apart from the general superiority of electric driving, is well worth noting, and with the general introduction of electric power, will contribute much to our knowledge of the utilization and waste of power.

Relations Between Engine and Generator Builders.

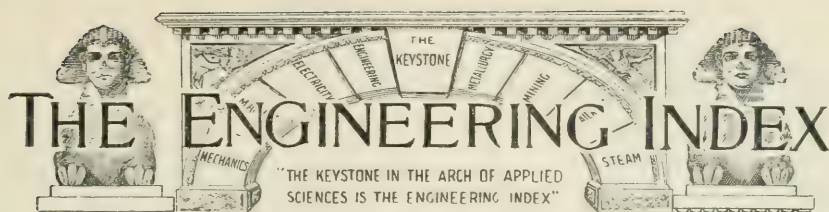
ONE of the conspicuous features of the power section of the Paris Exposition was the almost universal practice of combining steam engines and electric generators into sets, the generator being either direct-connected to the engine shaft or forming an integral structure with the fly-wheel. This practice is also becoming so common in the United States that it formed the main portion of the discussion at the recent meeting of the Engine-Builders' Association, papers being presented by both builders of engines and generators.

Although in some cases the generating sets, as they are now commonly called, are built entirely by one establishment, yet in the majority of instances the engines and electrical work are the products of different shops. If the benefits of standardization are to be obtained it is therefore necessary that there should be some general uniformity of practice, not necessarily in details of design or construction, but in proportion and dimensions of parts common to both portions of the combined structure, so that the customer may be able to choose the engine and the generator and yet permit open competition.

The main things to be considered are that the engine and generator should be analogous so far as capacity, speed, and regulation are concerned. Electric generators are designed to permit of a decided overload for a brief period, experience having shown the great advantage of this, but this overload capacity avails nothing if the steam portion of the set is not equally proportioned.

When generators are to be run in multiple the governing of the engines is an important matter and should be considered with respect to its peculiar service. The absolute uniformity of speed is not so important as the limit of angular variation. Steam engines intended for directly connected dynamos should not have an angular deviation in degrees of more than $2\frac{1}{2}$ or 3 degrees of phase. In order to obtain this result it is necessary so to proportion the fly-wheel, relative to the weight of the other moving parts, as to make sure that the limit of angular variation is not exceeded, and this cannot be done unless the engine maker and the generator builder act in harmony.

The whole subject of the standardization of direct-connected sets is under consideration by a joint committee of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, and now that the matter has also been taken up by the Engine-Builders' Association there is every reason to believe that satisfactory standard proportions in essentials will be secured without hindering the progress of invention and improvement in both branches.



The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language*; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of \$1.00; G, of \$1.20; and H, of \$1.60. In ordering, care should be taken to give the number of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for \$2.00, thirty-three for \$5, and one hundred for \$10.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of *THE ENGINEERING MAGAZINE* at 10 cts. per month, or \$1.00 a year; to non-subscribers, 25 cts. per month, or \$3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: *Ill*—Illustrated; *W*—Words; *Anon*—Anonymous.

American Architect. *w*. Boston, U. S. A.
 American Electrician. *m*. New York.
 Am. Engineer and Railroad Journal. *m*. New York.
 American Gas Light Journal. *w*. New York.
 American Geologist. *m*. Minneapolis, U. S. A.
 American JI. of Science. *m*. New Haven, U. S. A.
 American Machinist. *w*. New York.
 Am. Manufacturer and Iron World. *w*. Pittsburg, U. S. A.
 American Shipbuilder. *w*. New York.
 Annales des Pontes et Chaussées. *m*. Paris.
 Architect. *w*. London.
 Architectural Record. *qr*. New York.
 Architectural Review. *s-q*. Boston, U. S. A.
 Architect's and Builder's Magazine. *m*. New York.
 Australian Mining Standard. *w*. Sydney.

Automobile Magazine. *m*. New York.
 Automotor & Horseless Vehicle JI. *m*. London.
 Brick Builder. *m*. Boston, U. S. A.
 British Architect. *w*. London.
 Brit. Columbia Mining Rec. *m*. Victoria, B. C.
 Builder. *w*. London.
 Bulletin Am. Iron and Steel Asso. *w*. Philadelphia, U. S. A.
 Bulletin de la Société d'Encouragement. *m*. Paris.
 Bulletin of Dept. of Labor. *b-m*. Washington.
 Bulletin of the Univ. of Wisconsin, Madison, U. S. A.
 Bull. Int. Railway Congress. *m*. Brussels.
 California Architect. *m*. San Francisco, U. S. A.
 Canadian Architect. *m*. Toronto.

- Canadian Electrical News. *m.* Toronto.
 Canadian Engineer. *m.* Montreal.
 Canadian Mining Review. *m.* Ottawa.
 Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
 Colliery Guardian. *w.* London.
 Compressed Air. *m.* New York.
 Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
 Consular Reports. *m.* Washington.
 Contemporary Review. *m.* London.
 Deutsche Bauzeitung. *b-w.* Berlin.
 Domestic Engineering. *m.* Chicago.
 Eclairage Electrique. *w.* Paris.
 Electrical Engineer. *w.* London.
 Electrical Review. *w.* London.
 Electrical Review. *w.* New York.
 Electrical World and Engineer. *w.* New York.
 Electrician. *w.* London.
 Electricien. *w.* Paris.
 Electricity. *w.* London.
 Electricity. *w.* New York.
 Elektrizität. *b-w.* Leipzig.
 Elektrochemische Zeitschrift. *m.* Berlin.
 Elektrotechnische Zeitschrift. *w.* Berlin.
 Elettricita. *w.* Milan.
 Engineer. *w.* London.
 Engineer. *s-m.* Cleveland, U. S. A.
 Engineers' Gazette. *m.* London.
 Engineering. *w.* London.
 Engineering and Mining Journal. *w.* New York.
 Engineering Magazine. *m.* New York & London.
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
 Fire and Water. *w.* New York.
 Foundry. *m.* Detroit.
 Gas Engineers' Mag. *m.* Birmingham.
 Gas World. *w.* London.
 Génie Civil. *w.* Paris.
 Gesundheits-Ingenieur. *s-m.* München.
 Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
 Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
 Horseless Age. *m.* New York.
 Ice and Refrigeration. *m.* New York.
 Indian and Eastern Engineer. *m.* Calcutta.
 Iron Age. *w.* New York.
 Iron and Coal Trades Review. *w.* London.
 Iron & Steel Trades Journal. *w.* London.
 Iron Trade Review. *w.* Cleveland.
 Journal Assn. Eng. Societies. *m.* Philadelphia, U. S. A.
 Journal of Electricity. *m.* San Francisco.
 Journal Franklin Institute. *m.* Philadelphia.
 Journal of Gas Lighting. *w.* London.
 Journal Royal Inst. of Brit. Arch. *s-gr.* London.
 Journal of Sanitary Institute. *gr.* London.
 Journal of the Society of Arts. *w.* London.
 Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
 Journal Western Soc. of Eng. *b-m.* Chicago.
 Journal of Worcester Poly. Inst., Worcester, Mass.
 L'Energie Electrique. *w.* Paris.
 Locomotive. *m.* Hartford, U. S. A.
 Locomotive Engineering. *m.* New York.
 Machinery. *m.* London.
 Machinery. *m.* New York.
 Marine Engineering. *m.* New York.
 Marine Review. *w.* Cleveland, U. S. A.
 Metal Worker. *w.* New York.
 Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
 Mines and Minerals. *m.* Scranton, U. S. A.
 Mining and Sci. Press. *w.* San Francisco, U. S. A.
 Mining Reporter. *w.* Denver, U. S. A.
 Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
 Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
 Modern Machinery. *m.* Chicago.
 Moniteur des Architects. *m.* Paris.
 Moniteur Industriel. *w.* Paris.
 Municipal Engineering. *m.* Indianapolis, U. S. A.
 National Builder. *m.* Chicago.
 Nature. *w.* London.
 Nature. *w.* Paris.
 Nautical Gazette. *w.* New York.
 New Zealand Mines Record. *m.* Wellington.
 Nineteenth Century. *m.* London.
 North American Review. *m.* New York.
 Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
 Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
 Ores and Metals. *w.* Denver, U. S. A.
 Plumber and Decorator. *m.* London.
 Popular Science Monthly. *m.* New York.
 Power. *m.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Soc. Civil Engineers. *m.* New York.
 Proceedings Engineers' Club. *gr.* Philadelphia, U. S. A.
 Proceedings St. Louis R'way Club, *m.* St. Louis, U. S. A.
 Progressive Age. *s-m.* New York.
 Railroad Car Journal. *m.* New York.
 Railroad Gazette. *w.* New York.
 Railway Age. *w.* Chicago.
 Railway & Engineering Review. *w.* Chicago.
 Review of Reviews. *m.* London & New York.
 Revue de Mécanique. *m.* Paris.
 Revue Gen. des Chemins de Fer. *m.* Paris.
 Revue Technique. *b-m.* Paris.
 Revue Universelle des Mines. *m.* Liège.
 Rivista Marittima. *m.* Rome.
 Sanitary Plumber. *s-m.* New York.
 Schweizerische Bauzeitung. *w.* Zürich.
 Scientific American. *w.* New York.
 Scientific Am. Supplement. *w.* New York.
 Stahl und Eisen. *s-m.* Düsseldorf.
 Stevens' Institute Indicator. *gr.* Hoboken, U. S. A.
 Stone. *m.* New York.
 Street Railway Journal. *m.* New York.
 Street Railway Review. *m.* Chicago.
 Telephone Magazine. *m.* Chicago.
 Tramway & Railway World. *m.* London.
 Trans. Am. Ins. Electrical Eng. *m.* New York.
 Trans. Am. Ins. of Mining Eng. New York.
 Trans. Am. Soc. of Civil Eng. *m.* New York.
 Trans. Am. Soc. of Heat & Ven. Eng. New York.
 Trans. Am. Soc. Mech. Engineers. New York.
 Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
 Transport. *w.* London.
 Western Electrician. *w.* Chicago.
 Wiener Bauindustrie Zeitung. *w.* Vienna.
 Yacht. *w.* Paris.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
 Zeitschrift für Elektrochemie. *w.* Halle a. S.
 Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Building Details.

The Gill Building, New York. Illustrated description of the foundations and steel work in a 15-story, 56 x 86-ft. building. A number of the connections in the metal work are of special design. 2500 w. Eng Rec—Nov. 3, 1900. No. 37509.

Building Support.

A Novel Method of Supporting a Building Over a Running Stream. Illustrated description of the solution of a troublesome problem in construction, in connection with extensions of the plant of the N. Y. Rubber Co., at Matteawan, N. Y. 800 w. Eng News—Nov. 15, 1900. No. 37680.

Changes.

Structural Changes in the Hotel Iroquois. Illustrates and describes the method of adding three stories of steel-cage construction on the top of the old walls of a Buffalo building. 450 w. Eng Rec—Nov. 24, 1900. No. 37930.

Cold Storage.

A Modern Small Cold Storage House. Eugene T. Skinkle. Discusses what is the best material for construction, how to build, piping, etc. Ill. 1600 w. Ice & Refriger—Nov., 1900. No. 37514 C.

Color Treatment.

The Color Treatment of the Pan-American Exposition. Edward Hale Brush. An account of the plans to carry out the color scheme with success. 1800 w. Sci Am—Nov. 10, 1900. No. 37557.

Exposition.

The Festival Hall of the Exposition (La Salle des Fêtes de l'Exposition). G. Bähr. A very complete account of the structural work of the building constructed within the old Machinery Hall of the Exposition of 1889 for the ceremonial events of the Exposition of 1900. 3000 w. 1 plate. Génie Civil—Nov. 3, 1900. No. 37802 D.

Foundations.

Reconstructing the Defective Foundations of the Hotel Wollaton, Brookline, Mass. A description of the defective foundation and its probable cause, and of the proposed method of repairing it. 1300 w. Eng News—Nov. 15, 1900. No. 37681.

The Pneumatic Caisson Foundations for the Broad-Exchange Building, New York City. An illustrated description of the apparatus and methods of work in

constructing the foundations of what will be the largest office-building in the United States. 2500 w. Eng News—Nov. 15, 1900. No. 37689.

Office Building.

The Broadway-Chambers. Illustrated description of a fine 18-story building in New York, which was fully represented at the Paris Exhibition. 1200 w. Arch & Builds' Mag—Nov., 1900. No. 37577 C.

Tenements.

Tenement Houses. Edward T. Potter. Answer to a circular letter of inquiry concerning the design and construction desirable. 7500 w. Am Archt—Nov. 24, 1900. No. 37914.

HEATING AND VENTILATION.

Drying.

A Modern Steam Dry Floor. C. M. Hurt. Illustrated description of the construction and regulation of floors for drying clay workers' wares, and a statement of their advantages. 2500 w. Brick—Nov. 1, 1900. No. 37521.

Heating System.

A Residence Heated by a Furnace. Illustrates and describes a hot-air furnace which satisfactorily heats 18 rooms. 1900 w. Met Work—Nov. 10, 1900. No. 37576.

Hygrometer.

Use of the Hygrometer in Studies of Ventilation. A review of a paper by J. H. Kincaid. 2300 w. Jour Gas Lgt—Nov. 20, 1900. No. 37938 A.

Schools.

A Typical Chicago School Heating and Ventilating Plant. Illustrated detailed description of the system used. 2800 w. Eng Rec—Nov. 24, 1900. No. 37932.

Heating and Ventilating in a Small Schoolhouse. Illustrated description of the system in a 12-room building, using direct steam radiation. 1500 w. Eng Rec—Nov. 10, 1900. No. 37587.

PLUMBING AND GAS FITTING.

Drainage.

The Drainage of a House. William Paul Gerhard. Discusses progress made in house sanitation; the essential points of sanitary plumbing; the construction and fundamental requirements. 3500 w. Dom Engng—Nov. 15, 1900. No. 37721 C.

Gymnasium.

A New York Public Bath and Gym-

nasium. Illustrated description of a recreation building in a tenement house district in New York. 600 w. Eng Rec—Nov. 10, 1900. No. 37586.

Materials.

Improvements in Plumbing Materials. David Whiteford. Comments on recent changes, and plumbing developments. 1800 w. Dom Engng—Nov. 15, 1900. No. 37722 C.

Swimming Bath.

A Racquet Club Swimming Bath. Illustrated description of the details of a 15 x 22-ft. plunge bath with special features of waterproofing at the sides and bottom. 700 w. Eng Rec—Nov. 3, 1900. No. 37511.

MISCELLANY.

Estimating.

Estimating. Fred. T. Hodgson. Presents the simplest possible methods of obtaining quantities required in estimating materials. 2200 w. Archts' & Builds'

Mag—Nov., 1900. Serial. 1st part. No. 37578 C.

Exposition.

The Pan-American Exposition at Buffalo, N. Y., in 1901. Brief illustrated description of the plans and scope of this exposition, with statement of the progress made at the present time. 3000 w. Eng News—Nov. 8, 1900. No. 37600.

Hanging Bells.

Method of Hoisting a Set of Large Bells. E. J. Lennox. A description of method of hoisting the large bells to the tower of the new city buildings in Toronto, Can. Ill. 800 w. Can Archt—Nov., 1900. No. 37915 C.

Windows.

Diffusion of Light. Edward Atkinson. The present article reports experiments made and conclusions, and begins the discussion of the advantage of this principle in lighting factories, work shops, school-rooms, etc. 4000 w. Am Archt—Nov. 10, 1900. Serial. 1st part. No. 37633.

CIVIL ENGINEERING

BRIDGES.

Cantilever.

Strengthening the Michigan Central R. R. Cantilever Bridge, Niagara Falls, N. Y. Illustrated description of the methods and details of the work. 2300 w. Eng News—Nov. 1, 1900. No. 37553.

Concrete Arch.

A Concrete Arch Railroad Bridge. Illustrated detailed description of a semi-circular, single-barrel arch of 15-ft. radius, recently put in service at Sharpville, Pa. 1500 w. R R Gaz—Nov. 16, 1900. No. 37669.

The Lamington Concrete Steel Bridge. Describes the interesting features of a low-level bridge in Queensland. 1200 w. Eng Rec—Nov. 17, 1900. No. 37777.

Construction.

Improvements in Bridge Construction. Report on the exhibit of the Pencoyd Iron Works, at the National Export Exposition, held in Philadelphia, Oct.-Nov., 1899. 1600 w. Jour Fr Inst—Nov., 1900. No. 37456 D.

Ferry-Bridge.

The Ferry-Bridge at Bizerta. Illustrated description. 800 w. Sci Am Sup—Nov. 3, 1900. No. 37428.

Girders.

Old Girders. A report of an engineer's experiences with these girders, showing

them only fit for the scrap heap, and suggesting that a most careful examination be made of all such material that it is proposed to use again. Ill. 1600 w. Engr, Lond—Oct. 26, 1900. No. 37531 A.

The Development of the Fundamental Equations of a Girder (Entwicklung der Grundgleichungen eines Tragers). Prof. Ramisch. A mathematical development of a new theory for girders, with any given number of supports. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 19, 1900. No. 37815 B.

Removal.

An Interesting Bridge Removal. Illustrated description of method of moving a 375-ft. single track bridge nearly a mile. 400 w. Eng Rec—Nov. 3, 1900. No. 37506.

Specifications.

Proposed Specifications for Steel Railroad Bridges. J. W. Schaub. Gives proposed methods explaining why they are advocated, also specifications, and a general discussion. 2000 w. Jour W Soc of Engrs—Oct., 1900. No. 37417 D.

Suspension.

A Footway Suspension Bridge with Three Towers, at Easton, Pa. H. G. Tyrrell. Drawings, description, and extracts from specifications. 1100 w. Eng News—Nov. 22, 1900. No. 37922.

The New Chain Bridge at Budapest. Illustrated description of a suspension

bridge of 1,242 ft. total span, having chains of links machined from plates by means of special tools. 2400 w. Eng Rec—Nov. 10, 1900. No. 37581.

Swing Bridge.

The Neuhoof Swing-Bridge Over the Reiherstieg at Hamburg-Neuhof (Die Drehbrücke Neuhoof über den Reiherstieg bei Hamburg-Neuhof). C. Bernhard. A full account of the details of this peculiar example of swing-bridge construction, with strain diagrams and other illustrations. Two articles. 7500 w. Zeitschr d Ver Deutscher Ingenieure—Oct. 20, 27, 1900. No. 37812 each D.

Trusses.

The Development of Bridge Members. A discussion of the relative advantages of eye bars and built sections for tension chords. 1000 w. Eng Rec—Nov. 10, 1900. No. 37579.

The Development of Bridge Trusses. An editorial discussion of present tendencies in American bridge design. 800 w. Eng Rec—Nov. 3, 1900. No. 37502.

The Strength of End Joints in Wooden Trusses. F. E. Kidder. An analysis of the tests on truss joints made in the engineering laboratories of the Mass. Inst. of Tech. in 1897. Ill. 2200 w. Eng Rec—Nov. 17, 1900. No. 37776.

Viaduct.

The Grasshopper Creek Viaduct. Illustrated description of a viaduct 650 ft. long, with a maximum height of 88 ft. above the tops of the masonry pedestals of the tower posts. 1000 w. Eng Rec—Nov. 24, 1900. No. 37929.

Willis Avenue Bridge.

The Willis Avenue Bridge, New York. Illustrated detailed description of bridge across the Harlem River, which is 60 ft. wide and 2,507 ft. long. 2500 w. Eng Rec—Nov. 17, 1900. No. 37774.

CONSTRUCTION.

Foundations.

See Architectural Engineering, Construction.

Pile-Driving.

Notes on Pile-Driving. James C. Haugh. Discussion of experience in pile-driving by the writer and members. 3700 w. Jour Assn of Engng Socs. Sept., 1900. No. 37447 C.

Reinforced Concrete.

Monier Constructions. E. Lee Heidenreich. Gives the different formulæ used in the calculations, also papers and discussion of this subject containing matter of interest. Ill. 3500 w. Jour W Soc of Eng—Oct., 1900. No. 37415 D.

Roads.

American Road Builders in Porto Rico.

Albert Wells Buel. Information concerning the work in progress, the difficulties, cost, etc. Ill. 1800 w. R R Gaz—Nov. 23, 1900. No. 37747.

Fallacies and Facts Concerning Good Roads. Editorial on a paper by I. O. Baker, printed in *The Technograph*, concerning misleading statistics that have been published. 2500 w. Eng News—Nov. 15, 1900. No. 37686.

Shell Roads in Maryland. Extract from the Maryland Geol. Survey's Report on the State Highways, relating to roads surfaced with oyster shells. 1300 w. Eng Rec—Nov. 17, 1900. No. 37780.

Subways.

The Elm Street Subways in New York. An account of the scheme to build galleries for pipes on each side of the rapid transit subway, and the cause of the work being discontinued. Ill. 1200 w. Eng Rec—Nov. 17, 1900. No. 37775.

Tunneling.

The Simplon Tunnel (Le Tunnel de Simplon). A. Dumas. A very full and illustrated account of the work on the Simplon tunnel as conducted up to date, with maps, profile, and numerous views. 3500 w. Génie Civil—Oct. 27, 1900. No. 37808 D.

HYDRAULIC AND MARINE.

Discharge of Water.

Diagram Giving Discharge of Pipes by Kutter's Formula. John H. Gregory. Illustrated description of a large diagram for determining the discharge, friction loss, the velocity and diameter of pipes 1,000 ft. long. The diagram is characterized by the good intersection of the various lines. 1300 w. Eng Rec—Nov. 3, 1900. No. 37505.

The Miners' Inch and the Discharge of Water Through Various Orifices Under Low Heads. Thos. Drummond. A record of water determinations made in the hydraulic laboratory of McGill Univ., Montreal, with explanation of the term "miners' inch." 3700 w. Can Soc of Civ Engs—Adv. Proof, Nov. 22, 1900. No. 37772 D.

Docks.

Manchester Dock Extension. An illustrated description of extensions made necessary by the increasing activity in traffic and circumstances connected. 1300 w. Builder—Oct. 27, 1900. No. 37540 A.

The New 750-ft. Dry-Dock of the San Francisco Dry-Dock Co., at Hunter's Point, Cal. Illustrated detailed description of a proposed addition to the dry-dock facilities of the Pacific Coast, its equipment, power plant, etc. 3000 w. Eng News—Oct. 25, 1900. No. 37550.

The Uruga Docks, Japan. Description, with illustrations, of a second set of docks

nearing completion. 1400 w. Engr, Lond
—Nov. 2, 1900. No. 37619 A.

Dredging.

Modern Methods of Deep Sea Sounding and Dredging. Harry C. Martin. Brief description, with illustration of a sounding machine. 900 w. Yale Sci M.—Nov., 1900. No. 37708 C.

New Dredger Built in Great Britain. Description of a trial trip of a new suction dredger, built on the Tyne on an American system. 1200 w. U. S. Cons Repts, No. 890—Nov. 19, 1900. No. 37703 D.

Filtration.

An Experimental Water Filtration Plant: Its Design, Use, Economy and Value. Floyd Davis. On the wisdom of experimental investigation before installing a system, and suggestions. 1000 w. Munic Engng—Nov., 1900. No. 37460 C.

Filtration for Moscow, Russia. Extract from article by M. Nicholas Simin, with brief review. 1200 w. Fire & Water—Nov. 3, 1900. No. 37570.

Specifications for a Mechanical Filter Plant. Extracts from specifications prepared for the Brooklyn water-works, giving the features of special interest. 1500 w. Eng Rec—Nov. 17, 1900. No. 37778.

The Benefit of Alum in Water Filtration. Charles V. Chapin, in the *Providence Medical Journal*. Report concerning the East Providence, R. I., filter, claiming there is no alum in the water after filtration, as shown by tests. 1800 w. San—Nov., 1900. No. 37498 D.

Water Filtration in Germany. E. Beer. Translation of parts of an address on the recent history of filtration in Germany, and the features which are yet to be settled. 3900 w. Eng Rec—Nov. 3, 1900. No. 37507.

Force Mains.

Wood-Stave Pipe for Force Mains. States the conditions at Atlantic City, N. J., which led to the recommendation of wood-stave pipe, with reasons for the choice. 1300 w. Eng Rec—Nov. 24, 1900. No. 37933.

Irrigation.

The Condition of Water and Power Development in Southern California. L. K. Sherman. On the great necessity of irrigation in this region, the types of construction used in water power development, etc. 2000 w. Jour W Soc of Eng—Oct., 1900. No. 37416 D.

Jetties.

Jetty Construction at Bilbao and Zeebrugge. Description of works, interesting because greatly facilitated by the novel method of constructing the piers by means of iron caissons filled with concrete. Ill. 1200 w. Engr, Lond—Nov. 2, 1900. No. 37617 A.

Nicaragua Canal.

The Nicaragua Canal Bill in Congress. Editorial discussion of the probability of the U. S. Congress authorizing the construction of this canal, and of matters related to the project. 1800 w. Eng News—Nov. 29, 1900. No. 37935.

Pollution.

The Pollution of Public Water Supplies in the United States. Report of the committee of the American Public Health Assn., presented at the Indianapolis meeting. 6000 w. Munic Engng—Nov., 1900. No. 37462 C.

Pumping Costs.

Cost of Pumping Water. William C. Webber. Conclusions reached from recent investigations of municipal plants, with chart showing graphically the relation that the cost of pumping 1,000,000 gals. one foot high, has to different quantities to different heights. 300 w. Power—Nov., 1900. No. 37454.

Purification.

The Present Status of Methods of Purification of Water in America. A report to the American Public Health Assn., by Allen Hazen, giving statistics of large plants. 1800 w. Eng Rec—Nov. 10, 1900. No. 37584.

The Status of Foreign Methods of Water and Sewage Purification. A statement prepared for the American Public Health Assn. 700 w. Eng Rec—Nov. 10, 1900. No. 37583.

River Improvement.

Chinese Trade and Chinese River Improvement. William Starling. Discussing especially the regulation of the Yellow River as an artery of commerce. 4000 w. Engineering Magazine—Dec., 1900. No. 37862 B.

Hoogli River—Proposed Deep Water Approach to Calcutta. Lindon W. Bates. Describes the physical characteristics and discusses the remedial projects, giving the writer's proposals in detail. Plates. 13000 w. Jour W Soc of Eng—Oct., 1900. No. 37419 D.

The Débris Problem in the Sacramento Valley. Information from the Report of the California Débris Commission, concerning the prevention of injury to navigation in the Sacramento Valley from the enormous quantity of material washed into the river beds by hydraulic mining. 2500 w. Eng Rec—Nov. 24, 1900. No. 37931.

The Erosion of River Beds. Critical letter discussing the plan of improving the southwest pass of Mississippi as outlined by Lewis M. Haupt, with reply from the author. Ill. 3000 w. Eng News—Oct. 25, 1900. No. 37552.

The Canalisation of the Moldau and the Elbe in Bohemia (Die Canalisierung

des Moldau und Elbeflusses in Böhmen). H. Franz. Giving illustrations of the movable dams and details of the projected improvements. 2500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Nov., 1900. No. 37847 D.

The Meeker Island Dams and Locks. James A. Gould. Information concerning work under construction which will give Minneapolis a commercial waterway. Ill. 1700 w. Yale Sci M—Nov., 1900. No. 37707 C.

Sedimentation.

Sedimentation Tanks, with Numerous Circular Overflow Weirs; Denver Union Water Co. Illustrated description. 1000 w. Eng News—Nov. 15, 1900. No. 37687.

Ship Canals.

Central American Ship Canals. Devoted mostly to the Panama enterprise, giving the history of its development. Map. 3500 w. Engr, Lond—Oct. 26, 1900. Serial. 1st part. No. 37530 A.

Tunis.

The Ports of Tunis (Les Ports Tunisiens). An account of the present condition of the harbours of Sfax and Tunis, and suggestions as to their improvement. 2000 w. Revue Technique—Oct. 25, 1900. No. 37810 D.

Turbidity.

A Comparative Study of Methods Used for the Measurement of the Turbidity of Water. George C. Whipple and Daniel D. Jackson. A study of methods with the view of determining a standard, with conclusions. 4400 w. Tech Quar—Sept., 1900. No. 37501 E.

Waste.

Detection of Waste in the Water Supply of Towns. An account of the method of detection used in Torquay. Ill. 1200 w. Engr, Lond—Nov. 16, 1900. No. 37798 A.

Water Famine.

The Recent Water Famine in Paris; Water Waste and Purification. Abstracted by Allen Hazen from an article in *Technologie Sanitaire*, written by Adolph Kemna. Discusses the evident waste of water, and many problems connected with the supply. With editorial. 3800 w. Eng News—Oct. 25, 1900. No. 37549.

Water Supply.

The Limited Water Supply of the Arid Region. Frederick H. Newell. Statements of conditions and facts concerning the probability of the development of these regions. 1500 w. Nat Geog Mag—Nov., 1900. No. 37499 C.

The Pollution of Public Water Supplies. Extracts from the report to the

American Public Health Assn., summarizing the features of the situation in the United States in 1900. 3600 w. Eng Rec—Nov. 3, 1900. No. 37510.

The Water Supply Tunnels of Chicago. An illustrated detailed description of the entire system, giving also the history of the Chicago water supply. 7000 w. Eng News—Oct. 18, 1900. No. 37542.

Water Works.

Flood-Water Channel of the Altoona, Pa., Reservoirs. Charles W. Knight. Illustrated detailed description. 2000 w. Fire & Water—Nov. 3, 1900. No. 37569.

Wells.

The Wells of the Ottakring Brewery (Die Brunnen der Brauerei in Ottakring). Ph. Forchheimer. Describing the method adopted for sinking and lining wells to a depth of 279.7 metres (918 feet). 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 9, 1900. No. 37846 B.

MATERIALS.

Cement.

Portland Cement—Sketch of Materials and Process. T. B. Newberry. General description of the Portland cement industry. 4300 w. Eng Rec—Nov. 10, 1900. No. 37580.

Concrete.

Tests of Concrete for Elastic Properties and Ultimate Strength. W. H. Henry. Gives results of tests and conclusions derived from them, and considers briefly some of the factors entering into the mixing and placing of concrete which affect its efficiency. 2800 w. Jour Assn of Engng Socs—Sept., 1900. No. 37448 C.

Impact.

An Apparatus for Experiments in Impact. W. K. Hunt and W. P. Turner. Extracts from a paper before the Paris International Congress for the Unification of Tests of Materials. Illustrated description of impact testing machines and their use. 1700 w. R R Gaz—Nov. 23, 1900. No. 37744.

MEASUREMENT.

Spirit Levels.

Spirit Levels on Engineer's Field Instruments. Harold Van Duzee. Discusses the reliability of the spirit levels attached to transits and levels. 4000 w. Eng News—Nov. 22, 1900. No. 37923.

MUNICIPAL.

Garbage.

How Properly to Collect and Dispose of Garbage. H. P. Scherer. Explains the methods used in disposing of garbage by total incineration, giving suggestions from experience at Ft. Wayne, Ind., where the crematory has been in success-

full operation for five years. 3500 w. Munic Engng—Nov., 1900. No. 37461 C.

Pavements.

Construction and Maintenance of Brick Pavements. E. A. Kemmler. Facts concerning paving material used in Columbus, O. Estimates the average life of brick pavements on concrete foundation and with proper maintenance at from eighteen to twenty years. 4400 w. Brick—Nov. 1, 1900. No. 37519.

Refuse Utilization.

Refuse Destruction and the Displacement of Coal. Information from report made to the Rotherhithe Vestry by its surveyor. 1700 w. Ir & Coal Trds Rev—Nov. 9, 1900. No. 37711 A.

Sewage Purification.

Mechanical Aids to Sewage Purification. Illustrated description of apparatus whereby sewage itself can aid in its own purification, the flow of the sewage furnishing the motive power for the periodic feeding of filter beds. 2000 w. Engr, Lond—Nov. 16, 1900. No. 37799 A.

The Proposed Septic Tank and Sewage Purification Studies at Washington University. Reviews the past work in this field, and the proposed further experiments. 2300 w. Eng News—Nov. 15, 1900. No. 37683.

Sewerage.

Converting Portions of the Los Angeles

Outfall Sewer Into a Septic Tank. Detailed description of a method of solving a serious engineering difficulty. 4000 w. Eng News—Nov. 8, 1900. No. 37601.

Streets.

Pavement History of Lafayette. W. K. Eldridge. Historical review of local progress from the first efforts at street improvement to the present successful condition. 1300 w. Munic Engng—Nov., 1900. No. 37459 C.

MISCELLANY.

Address.

Presidential Address of Mr. James Monsergh before the British Institution of Civil Engineers. Also editorial. 10200 w. Engng—Nov. 9, 1900. Serial. 1st part. No. 37694 A.

Roads.

Oiled Roads and Their Benefit. Paper by T. F. White, describing the results of sprinkling oil on roads in Southern California. 2500 w. Eng Rec—Nov. 10, 1900. No. 37582.

Wales.

Engineering in Wales. W. H. Preece. An address delivered before the Society of Ancient Britons, Birmingham, Eng. 1800 w. Engng—Nov. 9, 1900. Serial. 1st part. No. 37695 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Inductance.

The Inductance of Concentric Cables. W. H. Everett. Gives results of investigations, showing that the interior field is not always negligible. 1200 w. Elec Rev, Lond—Nov. 9, 1900. No. 37700 A.

Space Telegraphy.

Experiments on Hertzian Telegraphy with a Telephonic Receiver. An account of some experiments by M. Guarini. Ill. 500 w. Elect'n, Lond—Nov. 9, 1900. No. 37701 A.

Wireless Telegraphy with Repeaters. E. Guarini and Lieut. Poncelet. Remarks on the inconveniences of successive Guarini relays. 500 w. Elec Rev, Lond—Nov. 16, 1900. No. 37790 A.

Telautograph.

Ritchie's Telautograph. An illustrated detailed account of a new writing telegraph and its capabilities. 1500 w. Elect'n, Lond—Nov. 16, 1900. No. 37787 A.

Telegraphs.

The Telegraph System of Siberia. H.

L. Geissel. Interesting information concerning the establishment of telegraphic communication across Siberia, showing the country quite advanced in this respect. 1800 w. Elec Wld & Engr—Nov. 17, 1900. No. 37673.

Telephones.

Telephone Pay Systems; Fixed Rentals and Measured Service or Tolls. C. E. McCluer. Reviews the mistakes made in the early systems and shows the need of a reliable recorder, in this first article. 2400 w. Elec Rev, N. Y.—Nov. 14, 1900. Serial. 1st part. No. 37719.

Telephone Service from Messenger Call-Boxes in New York City. Illustrated description of new telephone call-box, and an account of the way in which it will be installed. 800 w. Elec Rev, N. Y.—Nov. 7, 1900. No. 37630.

Telephony in Paris in the Exposition Year. An illustrated account of the service. 1500 w. Elec Wld & Engr—Nov. 3, 1900. No. 37482.

The Independent Telephone System at Pittsburg, Pa., of the Pittsburg and Allegheny Telephone Company. Kempster B.

Miller. Illustrated description of the main exchange, and of the operation of the system adopted. 3500 w. Elec Wld & Engr—Nov. 3, 1900. No. 37480.

The Muskegon, Mich., Independent Telephone Exchange. Illustrated detailed description. 1200 w. Elec Wld & Engr—Nov. 3, 1900. No. 37483.

DISTRIBUTION.

Alternating Currents.

Simple, Complex and Equivalent Harmonic Functions and the Application of Fourier's Series in Alternating Current Circuits. Harold B. Smith. Mathematical, with diagrams. 4400 w. Jour Worcester Polytechnic Inst—Nov., 1900. No. 37911 C.

Distribution.

See Street and Electric Tramways.

Franchises.

Street Franchises for Electric Circuits. Alton D. Adams. A discussion of the powers of towns and cities over their streets. 1200 w. Elec Wld & Engr—Nov. 17, 1900. No. 37674.

Insulation.

The Applications of Porcelain in Electrotechnics (Die Herstellung des Porzellans für die Elektrotechnik). J. Herzog and C. Feldmann. An account of the uses of porcelain in electrical work and a discussion of its properties and preparation. 10000 w. Elektrotech Zeitschr—Nov. 1, 1900. No. 37834 B.

Wiring.

Electric Wiring in Mines. Alton D. Adams. The difficulties which must necessarily be met, and some means of reducing the dangers of faulty insulation. 2000 w. Mines & Min—Nov., 1900. No. 37412 C.

ELECTRO-CHEMISTRY.

Electro-Engraving.

The Riedler Electro-Engraving Apparatus. Illustrated description of a machine exhibited at Paris, explaining the principle of its operation. 700 w. Sci Am—Nov. 3, 1900. No. 37426.

Electro-Galvanizing.

Commercial Electro-Galvanizing. H. H. Thayer, Jr. Describes some of the processes developed by the U. S. Electro Galvanizing Co. Ill. 1500 w. Sib Jour of Engng—Nov., 1900. No. 37734 C.

Fluorine.

Apparatus for the Commercial Production of Fluorine (Appareil pour la Fabrication Industrielle du Fluor). MM. Poulenc et Meslans. A description of an electrolytic process based on that of Moissan. 1200 w. L'Electricien—Nov. 3, 1900. No. 37840 B.

Paris Exhibition.

Electro-Chemistry at the Paris Exhibition. H. Borus. Commences a review of this department and the exhibits. 2800 w. Engng—Nov. 9, 1900. Serial. 1st part. No. 37691 A.

ELECTRO-PHYSICS.

Currents.

The Alteration in Current Forms by the Gratz Aluminum Cell (Ueber die Aenderungen der Stromform eines Normalen Wechselstromes durch Gratz'sche Aluminiumzellen). Dr. G. Mayrhofer. Showing especially the modifications produced in a normal alternating current. Two articles, 5000 w. Elektrotech Zeitschr—Nov. 1, 8, 1900. No. 37836 each B.

Lines of Force.

The Distribution of Lines of Force in Grooved Armatures (Die Vertheilung der Kraftlinien bei Nuthenankern von Gleich und Wechselstrom-maschinen). G. Dettman. An examination of the lines of force for continuous and for alternating current machines. The correctness of the conclusions is shown by the use of iron filings. 5000 w. Elektrotech Zeitschr—Nov. 15, 1900. No. 37848 B.

The Laws of the Distribution of Lines of Force in Alternators (Die Gesetze der Kraftlinienvertheilung ueber den Umfang der Wechselstrommaschinen). Ch. Westphal. A mathematical discussion, with diagrams showing the manner in which the lines of force are distributed around the circumference of an alternator. 3000 w. Elektrotech Zeitschr—Oct. 25, 1900. No. 37830 B.

GENERATING STATIONS.

Alternating Currents.

The Theory of Alternating Dynamo-Electric Mechanism. W. Elwell Goldsborough. Explains the manner in which alternating electro-motive forces are generated in commercial machines, and considers harmonic functions in the present article. 2000 w. Elec Rev, N. Y.—Oct. 31, 1900. Serial. 1st part. No. 37465.

British Stations.

Electric Central Station Practice in England. Frank C. Perkins. The St. Luke's and the Wandsworth stations are described and illustrated as typical examples. 3000 w. Engineering Magazine—Dec., 1900. No. 37865 B.

Dynamos.

Points on Determining Good Designs in Dynamos and Motors. W. L. Woodmansee. How to discriminate between good and bad designs. 1200 w. Engr, U. S. A.—Nov. 1, 1900. No. 37518.

Electricity Works.

Bury St. Edmunds Electricity Works. Brief history of the town and its illumination, with illustrated detailed description of the plant. 3500 w. *Elec Engr*, Lond—Nov. 2, 1900. No. 37610 A.

Electric Plants.

See Marine and Naval Engineering.

Gas Power.

Electric Plant Operated by Gas. Einar Rasmussen. Describes the generators and engines used to run an electric station in Norway. 800 w. *Am Mfr & Ir Wld*—Nov. 1, 1900. No. 37479.

Generating Set.

Combined Engine and Dynamo. Illustrated description of a high-speed engine and 220 kilowatt six-pole dynamo. The engine is of 400 h.-p., and is of the three-crank type. 1100 w. *Engr*, Lond—Nov. 9, 1900. No. 37698 A.

The Cail and Thomson-Houston Generating Set (Groupe Electrogène Cail et Thomson-Houston). Ch. Dantin. The Cail vertical compound engine of the Allis-Corliss design operated a Thomson-Houston alternator of 1000 kilowatts. 1800 w. 1 plate. *Génie Civil*—Nov. 10, 1900. No. 37804 D.

The Kolben-Carels Generating Set (Groupe Electrogène Kolben-Carels). F. Loppé. Illustrated description of the 1100 h. p. Carels engine and 825 kilowatt three-phase Kolben generator, exhibited together at Paris. 3000 w. *L'Electricien*—Nov. 17, 1900. No. 37850 B.

India.

Electrical Development Schemes in India. Particulars of a scheme for utilizing the power of Cauvery Falls for working the goldfields of the Kolar district of Mysore. Ill. 2500 w. *Elec Rev*, Lond—Nov. 2, 1900. No. 37611 A.

Isolated Plant.

An Interesting Residence Lighting Plant. Illustrated description of a plant for lighting a country residence, comprising seven scattered buildings. 1300 w. *Eng Rec*—Nov. 17, 1900. No. 37779.

The Power Plant of the Massachusetts General Hospital, Boston, Mass. F. W. Dean. Illustrated description of a combined plant for two institutions. 1800 w. *Trans Am Soc of Mech Engrs*, No. 871—Dec., 1900. No. 37755 C.

Kander.

The Electric Station on the Kander (Das Elektrizitätswerk an der Kander). Dr. H. Rupp. A fully illustrated description of this important hydraulic electric power station in Switzerland, which supplies the Bürgdorf-Thun three-phase electric railway. 5000 w. *Elektrotech Zeitschr*—Nov. 1, 1900. No. 37833 B.

Paris Exhibition.

French and German Polyphase Generating Units at the Paris Exposition. C. L. Durand. Details of construction and operation of the large machines of the Fives-Lille Co. and the Augsburg-Nuremberg Co. 1600 w. *Elec Rev*, N. Y.—Nov. 14, 1900. No. 37718.

Power Plants.

See Mechanical Engineering, Hydraulics.

Supply.

Electricity Supply. W. A. Chamen. Read at meeting of the Glasgow Local Section of the Inst. of Elec Engrs. Discusses the system and pressure of supply, having special bearing as applied to the city of Glasgow. 3800 w. *Elect'n*, Lond—Nov. 16, 1900. No. 37788 A.

Winding.

The Computation of Windings (Berechnung des Durchmessers bei Gegebener Zahl der Amperewindungen, der Spulendimensionen, und der Spannung). Arthur Löwit. Deriving convenient formulas for the proper diameter of wire for a given number of ampere turns, coil diameter, and pressure. 600 w. *Elektrotech Zeitschr*—Oct. 25, 1900. No. 37831 B.

LIGHTING.**Arcs.**

The Alternating Current Arc. C. Wiler. Read before the Chicago Elec. Assn. An account of research work based on the study of the arc by means of the oscillograph. Also editorial. 2400 w. *Elec Wld & Engr*—Nov. 10, 1900. No. 37594.

Exposition.

The Chateau d'Eau and the Illuminated Fountains (Le Chateau d'Eau et les Fontaines Lumineuses). E. Cayla. Giving details of the construction of the ornate façade of the Electricity Building and the brilliantly illuminated fountains contained in it, and placed before it. 2500 w. *Génie Civil*—Nov. 3, 1900. No. 37803 D.

Frontier Plant.

A Frontier Electric-Light Plant. George D. Shepardson. Illustrated description of the plant at Gardiner, Mont., a village having a population of about 100 inhabitants. 900 w. *W Elect'n*—Nov. 10, 1900. No. 37629.

Incandescent.

A New System of Electric Lighting. Illustrates and describes a new system by which the lamps can be placed in any location. It consists in employing surfaces under which positive and negative conductors are interlaced while being insulated from one another. 1300 w. *Engr*, Lond—Oct. 26, 1900. No. 37645 A.

The Incandescent Lamp. H. D. Bur-

nett. Read at meeting of Peterborough Engng. Club. Reviews the history and development. 6000 w. Can Elec News—Nov., 1900. No. 37655.

Interior Illumination.

A Study of Certain Shades and Globes for Electric Lights, as Used in Interior Illumination. William Lincoln Smith. Illustrated account of tests made upon leading types of shades and globes, with results and description of methods of testing. 6600 w. Tech Quar—Sept., 1900. No. 37500 E.

Lamp Connections.

Standard Connections for Lamps with Edison Screw Contact (Verbande-Normalien und Kaliber lehren für Lampenfüsse und Fassungen mit Edison Gewinde kontakt). R. Hundhausen. An abstract of the official report of the Commission for standardization of incandescent lamp connections. 3000 w. Elektrotech Zeitschr—Nov. 8, 1900. No. 37837 B.

MEASUREMENT.

Accumulators.

The Determination of the Capacity of Accumulators (Ueber die Vorausbestimmung der Erforderlichen Kapazität von Akkumulatorbatterien). C. A. Rossander and E. A. Forsberg. A mathematical discussion, giving a graphical construction, enabling the capacity to be determined for variable discharge. 2500 w. Elektrotech Zeitschr—Oct. 25, 1900. No. 37832 B.

Dielectrics.

Notes on the Testing of Modern Dielectrics at High Voltages. J. Wright. On the present system of testing to guarantee the insulation of the core. 1600 w. Elec Rev, Lond—Oct. 26, 1900. No. 37538 A.

Dynamometer.

A New Transmission Dynamometer. Discussion at Philadelphia, May 16, 1900, of paper by W. Elwell Goldsborough. 2500 w. Trans Am Inst of Elec Eng—Oct., 1900. No. 37727 D.

Meters.

Electric Meters on Power Circuits. P. I. Panamolo. Suggestions concerning the installation and care of the meters. Ill. 1800 w. W Elect'n—Nov. 17, 1900. No. 37916.

Open Circuits.

The E. M. F. of Alternators on Open Circuit. C. C. Hawkins. Discusses the manner of determining the E. M. F. 900 w. Elec Rev, Lond—Oct. 26, 1900. Serial. 1st part. No. 37539 A.

Photometry.

Vielle on Contemporary Photometry. A summary of the chief points of interest in this report presented at the Elec. Con-

gress at Paris. 1800 w. Jour Gas Lgt—Oct. 30, 1900. No. 37591 A.

Wheatstone Bridge.

The Calibration of Precision Bridges (Bemerkungen über Aichung von Präzisionsbrücken). Dr. M. T. Edelmann. A discussion of the testing and calibration of precision bridges of the Wheatstone type. 1800 w. Elektrotech Zeitschr—Nov. 1, 1900. No. 37835 B.

POWER APPLICATION.

Alternating Currents.

Alternating-Current Motors in a Large Textile Mill. A. F. McKissick. Illustrated description of a water-power development, at Pilzer, S. C. 1700 w. Am Elect'n—Nov., 1900. No. 37484.

Electric Vehicles.

See Mechanical Engineering, Automobileism.

Elevators.

Electric Elevator Control. Hayward Cochrane. Abstract of a paper read before the Chicago Elec. Assn. States the requirements of electric elevator controllers, discusses their operation, etc. Ill. 2700 w. Am Elect'n—Nov., 1900. No. 37486.

Factory Plant.

Electrical Installation of the Milwaukee Harvester Company. Illustrated detailed description of a fine plant. 2500 w. W Elect'n—Nov. 24, 1900. No. 37917.

Induction.

The Induction Motor. B. A. Behrend. The first of a series of essays. A careful treatment of the subject, with much new experimental information. 1800 w. Elec Wld & Engr—Nov. 3, 1900. Serial. 1st part. No. 37481.

Machine Driving.

Electric Power at the Patent Shaft and Axletree Company's Works. Illustrated description of a three-phase electric power installation in England. 1800 w. Engng—Nov. 2, 1900. No. 37612 A.

The Electric Distribution of Power in the Amman Cotton Mills at Pordenone (Distribuzione Elettrica di Forza Motrice nel Cotonificio Amman E. C., in Pordenone). With numerous illustrations showing the manner in which the motors are applied. 2500 w. 1 plate. Industria—Oct. 14, 1900. No. 37841 D.

Mining Plant.

Electricity in Mining. Henry Louis. Abstracts from a series of papers in the *Mining Journal* of London, treating of advanced English and European practice. 2500 w. Mod Mach—Nov., 1900. No. 37566.

Electric Power on the Comstock Lode. Wynn Meredith and Wyatt H. Allen. Il-

illustrated description of a new transmission plant for use of the mines, with editorial notes. 4600 w. Elec Wld & Engr—Nov. 24, 1900. No. 37941.

Shops.

Power and Light for the Machine Shop and Foundry. Forrest R. Jones. Discusses the requirements to be fulfilled by an electric system for power transmission and lighting, and the system selected for a large plant. 6900 w. Trans Am Soc of Mech Eng, No. 882—Dec., 1900. No. 37766 C.

TRANSMISSION.

Insulation.

The Use of Cellulose Paper in Electro-technics (Ueber die Verwendung der Holzfaser in Form von Papier in der Elektrotechnik). Dr. J. Rabinowicz. Giving a comparison of the insulating value of various materials, and showing the applicability of wood-fibre paper for insulating wire. 3000 w. Elektrotech Zeitschr—Nov. 15, 1900. No. 37849 B.

MISCELLANY.

Address.

Electrical Engineering as a Trade and as a Science. John Perry. Inaugural address delivered at meeting of the Inst. of

Elec. Engs., England. 9800 w. Nature—Nov. 8, 1900. No. 37706 A.

Argentina.

Electrical Enterprise in Argentine. Ernesto Danvers. Extracts from a paper read before the Inst. of Engs. of the River Plate, Buenos Aires, Argentina. The present article considers telegraphs, telephones and the electric light. 5000 w. Elec Rev, N. Y.—Nov. 14, 1900. Serial. 1st part. No. 37720.

Paris Exposition.

The Paris Exposition of 1900. Carl Hering. Inaugural address of the president at the meeting of Am. Inst. of Elec. Engs., New York. 10000 w. Trans Am Inst of Elec Engs—Oct., 1900. No. 37726 D.

Radiography.

Cathode Rays. P. Villard. Abstract of lecture delivered before the Congress of Electricity, in Paris. Describes investigations and gives result of experimental study. 1800 w. Sci Am—Nov. 10, 1900. No. 37556.

The Cathode Stream and X-Light. William Rollins. Considers the ether theory, and the material particle theory, offering suggestions in regard to each. 5000 w. Am Jour of Sci—Nov., 1900. No. 37452 D.

GAS ENGINEERING

Acetylene.

Experiments on the Explosive Power of Acetylene Gas. Robert H. Fenn. Condensed from a graduating thesis presented at the Clarkson School of Technology, Potsdam, N. Y. Illustrates and describes the apparatus used and the tests made. 1600 w. Eng News—Nov. 29, 1900. No. 37934.

The Acetylene Flame. Edward L. Nichols. Reports the progress of investigations upon the properties of the acetylene flame, undertaken for the purpose of determining its usefulness in the physical laboratory. 7800 w. Jour Fr Inst—Nov., 1900. No. 37458 D.

Carbide.

The Application of Blast Furnace Gases to the Manufacture of Calcium Carbide (Die Benutzung der Hochofengase zur Fabrikation von Calcium Carbid). A discussion of the commercial practicability of using furnace gases for the generation of electric current for carbide manufacture. 1800 w. Glückauf—Nov. 10, 1900. No. 37829 B.

Coal Distillation.

Thermic Reactions in the Distillation of Coal. M. Euchène. Read at Gas Con-

gress at Paris. Gives the principal points in this lengthy communication, and the conclusions drawn from the investigations. Ill. 5700 w. Jour Gas Lgt—Oct. 30, 1900. Serial. 1st part. No. 37592 A.

Coke-Oven Gas.

Coke-Ovens as Gas-Works. From an article by Dr. H. Wiechell, in the *Journal für Gasbeleuchtung*. Examines the financial aspects of the question. 1900 w. Jour Gas Lgt—Nov. 6, 1900. No. 37679 A.

Conveyors.

See Mechanical Engineering, Power and Transmission.

Gas from Sewage.

Illuminating Gas from Sewage Sludge. Discusses the practicability of obtaining illuminating gas from this source. 2200 w. Jour Gas Lgt—Nov. 6, 1900. No. 37677 A.

Gas Heating.

Heating and Cooking by Gas. Auguste Lévy. Presented at the Paris Congress. On the investigations and tests of the Paris Gas Co., made to advance the use of gas for these purposes. 3400 w. Jour Gas Lgt—Nov. 6, 1900. No. 37678 A.

Gasholders.

Difficulties in the Construction of a Concrete Gasholder Tank. F. G. Cockey. Read before the London meeting of the So. Dist. Assn. of Gas Engs. and Mgrs. A record of personal experience, the difficulties and how met. Also discussion. 4000 w. Gas Wld—Nov. 17, 1900. No. 37784 A.

Gas Light.

Gas Light. A brief review of the history of gas lighting, the improvements in burners, and especially of the invention of Dr. Auer von Welsbach. 4800 w. Contemporary Rev—Nov., 1900. No. 37907 D.

Gas Power.

See Electrical Engineering, Generating Stations.

Guayaquil.

Notes on the Public Lighting of the Town of Guayaquil. Charles Guichard. Read before the Gas Congress at Paris. Description of means and apparatus adopted where defense against nocturnal insects is as necessary as protection from wind, rain, and earthquakes. Ill. 3000 w. Jour Gas Lgt—Oct. 23, 1900. No. 37431 A.

High Pressure.

High-Pressure Gas for Incandescent Lighting. A. W. Onslow. Read at London meeting of the So. Dist. Assn. of Gas Engs. and Mgrs. Gives result of experiments, and discusses the strength of mantles and related subjects. General discussion. 3000 w. Gas Wld—Nov. 17, 1900. No. 37785 A.

Illumination.

Report of the Committee on Research.—To Determine a Useful Working Standard for the Measure of the Illuminating Power of Gas. Describes research work, and gives short topical discussions by various contributors. 5000 w. Pro Age—Nov. 15, 1900. No. 37675.

Incandescence.

Intensified Gas-Lighting (Eclairage Intensif par le Gaz). J. Laverchère. A description of the high economy and brilliant illumination obtained at the Paris Exposition by the use of the Bandsept and the Denayrouze burners using gas at high pressure. 300 w. Génie Civil—Nov. 10, 1900. No. 37805 D.

The Theory of the Incandescent Gas Light. E. G. Love. Read at Denver meeting of the Am. Gas Lgt. Assn. A discussion of the theories and such other subjects as are needed for their clear understanding. 2500 w. Am Gas Lgt Jour—Nov. 5, 1900. No. 37517.

Mantles.

Self-Lighting Mantles. Abstract trans-

lation of article by M. Pierron, in the *Revue de Physique et de Chimie*, on the application to mantles of the principle of automatic ignition. 1800 w. Jour Gas Lgt—Oct. 23, 1900. No. 37432 A.

Power Gas.

Motive Power from High Furnace Gases. Bryan Donkin. A critical review of the development of the use of furnace gases for power generation, showing the probable great future of the method. 3500 w. Engineering Magazine—Dec., 1900. No. 37866 B.

Notes on the Question of Power-Gas Application (Beiträge zur Frage der Kraftgasverwerthung). A. Wagener. With special reference to the more recent utilization of furnace gases. 4000 w. I plate. Stahl und Eisen—Nov. 1, 1900. No. 37852 D.

Power-Gas Development (Beiträge zur Frage der Kraftgasverwertung). A. Wagener. A general review of the utilization of lean gases for power, with special reference to the large engines of the Oechelhäuser type recently built by the Deutsche Kraftgas-Gesellschaft. Two articles. 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 10, 17, 1900. No. 37844 each D.

Producer Gas.

Notes on the Use of Producer Gas in Burning Bricks. Carl Geissen. Reprint from the Trans. of the Am. Ceramic Soc. Describes the method and its advantages. Also general discussion. 4400 w. Brick—Nov. 1, 1900. No. 37522.

Purifiers.

Notes on Purifier Construction. G. P. Lewis. Read at London meeting of the Southern Dist. Assn. of Gas Engs. and Mgrs. Considers disadvantages of the water seal, proposed improvements in the "dry" system, cost, and the general problem of purification. Also discussion. Ill. 3500 w. Gas Wld—Nov. 17, 1900. No. 37783 A.

Theisen's Centrifugal Gas-Purifying Process. Translated from *Stahl und Eisen*. Illustrated description of the invention and the manner of operating, with information concerning the process. 3000 w. Ir & Coal Trds Rev—Oct. 26, 1900. No. 37529 A.

Pyrometer.

A Blue Glass Pyrometer. E. H. Earnshaw. Read at meeting of the Am. Gas Lgt. Assn. Illustrates and describes the apparatus, which aims to furnish a means of determining temperatures attained in the fixing chambers of water gas apparatus. 1200 w. Am Gas Lgt Jour—Nov. 19, 1900. No. 37716.

Retorts.

Inclined Retorts. A. H. Barret. Read

at Denver meeting of the Am. Gas. Lgt. Assn. Describes the installation and operation of a plant. 3000 w. Am Gas Lgt Jour—Nov. 5, 1900. No. 37516.

Standardization.

The Standardization of Gas-Meter Unions. J. Ferguson Bell. Presidential address before the Midland Assn. of Gas Mgrs., England, with discussion. 8000

w. Jour Gas Lgt—Nov. 13, 1900. No. 37743 A.

Water Gas.

The Removal of Tar from Water Gas. W. C. Morris. Read at meeting of Am. Gas Lgt. Assn. Considers the methods. Illustrations and general discussion. 1700 w. Am Gas Lgt Jour—Nov. 12, 1900. No. 37595.

MARINE AND NAVAL ENGINEERING

Air-Pump Test.

Capacity Test of a Unique Form of Air Pump. F. Meriam Wheeler. Describes a test made to ascertain the capacity of a new design of air pump for surface condensers, and especially intended for marine use. Ill. 2400 w. Trans Am Soc of Nav Archts & Marine Engs—Nov., 1900. No. 37656 D.

Battleships.

Rapid Battleship Building. Waldon Fawcett. Discusses the time economy in battleship construction made during the past two years, particularly in British and American yards. 1800 w. Pop Sci M—Nov., 1900. No. 37407 C.

The Japanese Battleship "Mikasa." An illustrated description of this recently launched vessel. 1400 w. Engng—Nov. 16, 1900. No. 37906 A.

The New Battleships. Illustration, with description of the characteristic features of five powerful vessels which are to be built for the U. S. Navy. 2200 w. Naut Gaz—Nov. 22, 1900. No. 37751.

The New Battleships. Illustration, with description of ships to carry superposed turrets, bearing the names "Georgia," "New Jersey" and "Pennsylvania." 1800 w. Sci Am—Nov. 17, 1900. No. 37650.

The Russian Warship "Novik." A discussion of this vessel and of torpedo boats and craft built to prey upon them. Also a description of the vessel. Ill. 2000 w. Engr, Lond—Nov. 16, 1900. No. 37795 A.

Coaling.

The Coaling of the U. S. S. "Massachusetts" at Sea. Spencer Miller. Describes the apparatus of the marine cableway for coaling at sea, discussing possible improvements and the importance of the work. Fully illustrated. 4000 w. Trans Am Soc of Nav Archts & Marine Engs—Nov., 1900. No. 37662 D.

Cruisers.

German Third-Class Cruiser "Amazon." Brief description, with illustration. 500 w. Engr, Lond—Nov. 2, 1900. No. 37618 A.

The Armored Cruiser "Jeanne d'Arc."

Illustrated detailed description. 800 w. Sci Am Sup—Nov. 17, 1900. No. 37652.

The French Cruisers "Cecille" and "Suchet" at New York. Illustrations, with brief descriptions of these vessels. 800 w. Sci Am—Nov. 3, 1900. No. 37425.

Deutschland.

The Twin-Screw Express Steamer "Deutschland" (Der Doppelschrauben Schnelldampfer "Deutschland"). A very complete account of the great Hamburg-American liner, with numerous details of hull and machinery. 10000 w. 5 plates. Zeitschr d Ver Deutscher Ing—Nov. 3, 1900. No. 37814 D.

Doors.

Water-Tight Doors. R. J. Donovan. Comments on types of water-tight doors fitted to bulkheads, and a short description of two of the most modern and their method of operation. 3000 w. Sibley Jour of Engng—Nov., 1900. No. 37733 C.

Electric Plants.

Tests of the Electric Plants of the Battleships "Kearsage" and "Kentucky." J. J. Woodward. Description of tests made to determine if all appliances used were properly constructed and installed, and to collect facts regarding their performance. 20000 w. 68 plates. Trans Am Soc of Nav Archts & Marine Engs—Nov., 1900. No. 37668 H.

Ferryboat.

Fine New Ferryboat. Illustration and description of the "San Pablo," built for service on San Francisco Bay. 1000 w. Naut Gaz—Nov. 8, 1900. No. 37608.

Launching.

The Launch of a Cruiser and a Battleship. James Dickie. Describes the launch of these vessels and also the slips on which they were built. Ill. 3500 w. Trans Am Soc of Nav Archts & Marine Engs—Nov., 1900. No. 37665 D.

Marine Engines.

See Mechanical Engineering, Steam Engineering.

Naval Vessels.

A Comparison of the Contract Prices of

Our Naval Vessels. Harrison S. Taft. Presents data concerning the relative cost of the vessels of each of the seven classes, the prices between different firms, the relative prices of different classes, and the tendency of prices. 3500 w. Trans Am Inst of Nav Archts & Marine Engs—Nov., 1900. No. 37664 D.

Recent Designs of Battleships and Cruisers for the United States Navy. Philip Hichborn. A description of the latest naval designs, supplemented by data and outline plans, without discussion of the merits or special features. 4300 w. Trans Am Soc of Nav Archts & Marine Engs—Nov., 1900. No. 37659 F.

Paris Exhibition.

The Messageries Maritimes at the Paris Exhibition. Detailed description, with illustrations, of the exhibits and the pavilion containing them. 1800 w. Engng—Nov. 16, 1900. No. 37904 A.

Reconstruction.

Rebuilding a Steamer on the Tyne. Describes the reconstruction of the Italian passenger steamer "Savoia." 600 w. U. S. Cons Repts, No. 874—Oct. 31, 1900. No. 37424 D.

Rules.

Classification Rules. Theodore Lucas. Remarks on the influence of classification regulations for the guidance of underwriters on the development of our merchant marine. Gives Lloyd's Rules, and the proposed standard specifications of the Am. Sec. of the International Assn. for Testing Materials. 6000 w. Trans Am Soc of Nav Archts & Marine Engs—Nov., 1900. No. 37667 D.

School Ship.

New York School Ship "St. Mary's." Illustration, with account of the service of this vessel. 600 w. Marine Engng—Nov., 1900. No. 37562 C.

Shipbuilding.

Can the American Shipbuilder Under Present Conditions Compete with the British and German Shipbuilders in the Production of the Largest Class of Ocean Passenger and Freight Steamships? George W. Dickie. Presents a comparison in skill in design, cost of labor, and cost of material. 3800 w. Trans Am Soc of Nav Archts & Marine Engs—Nov., 1900. No. 37660 D.

Notes on Recent Improvements in Foreign Shipbuilding Plants. H. G. Gillmor. The paper is based on observations made during recent visits, as compared with visits made several years ago. 2300 w. Trans Am Soc of Nav Archts & Marine Engs—Nov., 1900. No. 37661 D.

Speed.

The Steaming Radius and the Most Economical Speed of Steam Vessels.

Facts concerning the "El Sud," purchased by the United States and renamed "Yosemite," taken from an article by M. E. Cooley, published in *Technic*. 800 w. Eng News—Oct. 18, 1900. No. 37543.

Steamships.

Atlantic Steamships—Present and Future. Drawings and comparative data of the two classes of vessels now in favor, as represented by the "Ivernia" and the "Deutschland." Also editorial. 3200 w. Sci Am. Nov. 10, 1900. No. 37555.

Magnificent American Steamship for Coasting Service. Illustration, with a complete description, of the "Morro Castle," a steamer displacing over 8000 tons, and finely fitted. 3000 w. Naut Gaz—Nov. 15, 1900. No. 37723.

Transatlantic Liner "Commonwealth." Brief illustrated description of fine vessel for the Boston-Liverpool trade. 500 w. Marine Engng—Nov., 1900. No. 37563 C.

Steam Turbines.

The Steam Turbine in Large Merchant Steamers. George W. Melville. Gives personal views on the use of the turbine. Does not think it at present in a position to replace the reciprocating engine. 1400 w. Sci Am—Nov. 24, 1900. No. 37739.

Turbine Engines. Charles A. Parsons, in a letter to the London *Times*. Statement of the inventor regarding the trials of the "Viper." 1400 w. Naut Gaz—Nov. 8, 1900. No. 37609.

Submarine.

Construction and Machinery of the French Submarine Boats (Bau und Mechanismus der Französischen Unterseeboote). B. Denninghoff. A general account of the various experimental boats since 1888, and reference to those to be laid down in 1901. 2000 w. Schiffbau—Nov. 8, 1900. No. 37820 D.

Torpedo Boats.

The Safety of Torpedo Boats at Sea and in Action Under Various Conditions. Lloyd Bankson. Describes briefly what may be expected to occur when these vessels are seriously injured or in danger in bad weather, and what chances they may have of keeping afloat. 3 plates. 1000 w. Trans Am Soc of Nav Archts & Marine Engs—Nov., 1900. No. 37666 D.

Trial Tank.

The United States Experimental Model Basin. D. W. Taylor. A description of the basin and its appliances, fully illustrated. 7000 w. Trans Am Soc of Nav Archts & Marine Engs—Nov., 1900. No. 37658 F.

Units.

Interchangeability of Units for Marine Work. W. D. Forbes. Illustrations and suggestions concerning a proposed system. 1500 w. Trans Am Soc of Nav

Archts & Marine Engs—Nov., 1900. No. 37657 D.

Wharves.

A Timber Steamship Pier and Shed. Illustrated description of a heavy pier at Hoboken, N. J., designed for transatlantic steamship service. 1500 w. Eng Rec—Nov. 3, 1900. No. 37504.

Yachts.

A Composite Torpedo Boat. Illustrated detailed description of Charles R. Flint's "Arrow," which can be transformed from a torpedo-boat, carrying a complete armament, to a yacht, which may be used as

a dispatch boat. 3500 w. Ir Age—Nov. 22, 1900. No. 37728.

S. Y. "Arrow," Designed to Steam at the Rate of 40 Knots. Illustration and description of a vessel designed to attain the highest possible speed. 3000 w. Marine Engng—Nov., 1900. No. 37561 C.

The "Arrow." Full illustrated description of this fine high-speed vessel. 3200 w. Naut Gaz—Nov. 1, 1900. No. 37515.

The Twin-Screw Steam Yacht "Arrow." Illustrated description of a boat and its machinery designed for the attainment of extreme speeds. 3500 w. Sci Am Sup—Nov. 3, 1900. No. 37429.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Auto-Trucks.

The Heavy Auto-Truck in Great Britain and the United States. Robert Bodman. Considers the methods in Gt. Britain and compares the conditions with those prevailing in the United States; the possibilities of its proving a paying investment, and gives the writer's views. 2000 w. Horseless Age—Nov. 7, 1900. No. 37642.

Brakes.

Report on Brakes, Presented at the International Automobile Congress. M. L. Bochet. A discussion of devices and methods used in the operation of automobiles. 4000 w. Horseless Age—Nov. 21, 1900. No. 37738 C.

Electric Vehicles.

Electric Vehicles at the Madison Square Garden Show. P. M. Heldt. Reviews features of interest in the exhibits, showing the progress made. 2800 w. Horseless Age—Nov. 7, 1900. No. 37637.

Exhibition.

Exhibits at the Automobile Club's Show. Brief notice of the exhibits at Madison Sq. Garden, with illustrations. 3500 w. Horseless Age—Nov. 7, 1900. No. 37635.

The Exhibition. E. J. Stoddard. A review of the exhibits at Madison Square Garden, New York. 2500 w. Horseless Age—Nov. 7, 1900. No. 37638.

The Loan Exhibition of the Automobile Club. R. I. Clegg. Brief comments on the vehicles shown in this department at Madison Sq. Garden. 2900 w. Horseless Age—Nov. 7, 1900. No. 37643.

Fire Equipment.

Automobile Fire Equipment of Paris. Illustrated description of fire apparatus used at the French capital since March, 1899. 700 w. Fire & Water—Nov. 17, 1900. No. 37714.

French Trials.

The French Automobile Trials. G. A. Burls. An account of the trials at Vincennes, in connection with the Paris Exhibition. 2500 w. Auto Jour—Nov., 1900. No. 37782 A.

Locomobiles.

A Steam Motor Carriage. Illustrates and describes a vehicle to carry four persons, and gives some facts regarding its operation. 1700 w. Engr, Lond—Nov. 9, 1900. No. 37699 A.

Motor Cars.

Motors Cars as Feeders to Tramways and Otherwise. Henry Mozley. Illustrated description of a vehicle for carrying passengers either along country roads or in the city. 400 w. Tram & Ry Wld—Oct. 11, 1900. No. 37444 A.

The Wolseley Car. Illustrates and describes the car and the motor, which is a single-cylinder water-cooled engine, using petroleum spirit. 600 w. Engr, Lond—Oct. 26, 1900. No. 37533 A.

Motors.

Critical Review of the Carriages and Engines of the So-Called "Explosive Type" shown in the Recent Exhibition. Henry Power. 2500 w. Horseless Age—Nov. 14, 1900. No. 37676.

Hub Motor Automobiles. Brief illustrated description of vehicle with motor built into the hub of the wheel, so that no gearing of any sort is visible. 350 w. Elect'n, Lond—Oct. 26, 1900. No. 37535 A.

Novelties in Air-Cooled Motors at the Automobile Club's Show. Clarence C. Bramwell. Brief notice of the new examples. 600 w. Horseless Age—Nov. 7, 1900. No. 37644.

Steam and Gas Engines in Automobiles. R. H. Thurston. A discussion of some of the difficulties met in self-propelled vehicles. 2700 w. Horseless Age—Nov. 7, 1900. No. 37636.

Obstacles.

Resistance of Obstacles. Ernest J. Loring. Diagrams intended to explain the relation existing between the weight carried by a wheel, and the power required to force it over an obstacle. 600 w. Horseless Age—Nov. 21, 1900. No. 37737 C.

Running Gear.

American Tendencies in Automobile Running Gears. Herbert L. Towle. A review of present practice in America, and brief notice of European practice. Ill. 2000 w. Horseless Age—Nov. 7, 1900. No. 37640.

Selden Patent.

The Selden Patent Suit. Particulars of an interesting suit for patent infringement that may have the effect, if sustained, of closing the shops of many automobile makers. Ill. 1800 w. Sci Am—Nov. 24, 1900. No. 37741.

Speed Gear.

The Change Speed Question at the Automobile Club. Comments on the lack of progress in the devices used, and a discussion of the requirements. 1500 w. Horseless Age—Nov. 7, 1900. No. 37641.

Steam Vehicles.

Economy in Steam Vehicles. E. C. Oliver. The object of the paper is to point out certain lines along which improvement may be made. 3400 w. Horseless Age—Nov. 21, 1900. No. 37736 C.

Steam Vehicles at the Show. R. I. Clegg. A review of the exhibits at Madison Sq. Garden, with comments. 2800 w. Horseless Age—Nov. 7, 1900. No. 37639.

Trials.

Electric Motor Car Trials. An account of the trials of electric motor cars made near London, Eng. Ill. 2200 w. Elec Rev, Lond—Nov. 16, 1900. No. 37791 A.

HYDRAULICS.**Compressed Air.**

Pumping by Compressed Air. Edward A. Rix. The object of the paper is to discuss some neglected points, suggest some new methods, and encourage the designing of pumps especially adapted to the use of compressed air. Ill. 14000 w. Jour Assn of Engng Socs—Oct., 1900. No. 37909 C.

Lift Pumps.

Moving Water Horizontally by Air-Lift Pumps at Point Pleasant, Pa. Condensed from the *Metal Worker*. Clark Howell. An illustrated account of the plant. 2000 w. Eng News—Nov. 22, 1900. No. 37925.

Lifts.

The New Hydraulic Lifts for the Eiffel

Tower (Les Nouveaux Ascenseurs Hydrauliques de la Tour de 300 Metres). Ch. Dantin. A fully illustrated account of the new lifts installed to accommodate the increased travel at the Exposition of 1900. 2000 w. 1 plate. Génie Civil—Oct. 20, 1900. No. 37800 D.

Power Plant.

Another Great Hydraulic Power Plant. A full illustrated account of the St. Lawrence Power Company's undertaking, at Massena, N. Y. 3500 w. Ir Age—Nov. 8, 1900. No. 37571.

The St. Lawrence Power Company's Plant at Massena, N. Y. Brief illustrated description of interesting features. 1900 w. Sci Am—Nov. 17, 1900. No. 37649.

The St. Lawrence Power Plant at Massena. Illustrated description of works for an initial development of 37,500 h.-p., and final development of 150,000 h.-p. 1800 w. Eng Rec—Nov. 3, 1900. No. 37503.

Pumping Engines.

Barr Pumping Engine at Washington, D. C. Illustrated description, with extract from the report of the official test. 1000 w. Power—Nov., 1900. No. 37453.

Pumping Engines for the Coolgardie Pipe Line. Illustrated description of one of the six-cylinder, triple-expansion engines to be furnished for this pipe line in West Australia. The purpose is to supply water to the mining district, a distance of 325 miles. 1400 w. Eng News—Oct. 18, 1900. No. 37548.

Pump Tests.

Tests of Centrifugal Pumps. W. B. Gregory. Illustrations and description of two centrifugal pumps. 2000 w. Trans Am Soc of Mech Engrs, No. 869—Dec., 1900. No. 37753 C.

Turbines.

Turbines. Arthur Henry Tyack. Read before the Inst. of Civ. Engrs., Manchester, Eng. Part first gives description of various types. 1800 w. Elec, Lond—Nov. 2, 1900. Serial. 1st part. No. 37602 A.

Water Measurements.

Water Measurements in Connection with a Test of a Centrifugal Pump at Jourdan Avenue Drainage Station, New Orleans, La. W. M. White. States the object of the test, and gives an illustrated detailed description, with discussion of results. 3700 w. Jour Assn of Engng Socs—Oct., 1900. No. 37908 C.

MACHINE WORKS AND FOUNDRIES.**Brass Founding.**

The Use of Scrap Metals in Alloying. C. Vickers. Suggestions for the sorting and use of scrap. 1800 w. Am Mach—Nov. 1, 1900. No. 37436.

Yellow Brass Scrap. C. Vickers. Suggestions for making brass castings. 1700 w. *Am Mach*—Nov. 8, 1900. No. 37559.

Castings.

The Burning or Mending of Castings. Edward B. Gilmore. Describes the successful work of the writer, giving suggestions. Ill. 900 w. *Jour Am Found Assn*—Vol. 14, Part I. No. 37523 C.

The Orth Casting Apparatus. From *Stahl und Eisen*. Illustrated description of apparatus intended to facilitate the casting of molten iron into several rows of metallic moulds at once. 700 w. *Col Guard*—Nov. 2, 1900. No. 37615 A.

Centrifugal Fans.

Note on Centrifugal Fans for Cupolas and Forges. William Sangster. Formulae for the power required, with explanatory notes. 1200 w. *Trans Am Soc of Mech Eng*s, No. 872—Dec., 1900. No. 37756 C.

Connecting Rods.

Manufacturing Connecting Rods for Steam Engines. Describes the methods used in the manufacture. 1300 w. *Am Mach*—Nov. 15, 1900. No. 37648.

Cost Keeping.

Cost Keeping at the Chicago Works of Fraser & Chalmers. Describes a system that has been in satisfactory operation for four years. 2200 w. *Am Mach*—Nov. 1, 1900. Serial. 1st part. No. 37434.

The Expense Account of the Machine Shop. Horace L. Arnold. A discussion of an important element in cost keeping, showing the true method of treating indirect factory expenditures. 3500 w. *Engineering Magazine*—Dec., 1900. No. 37861 B.

Crucibles.

How Crucibles Are Made. H. C. Hovey. Interesting information relating to the process of manufacture, materials used, etc. 2000 w. *Sci Am Sup*—Nov. 24, 1900. No. 37742.

Flow of Metal.

A Remarkable Case of the Flow of Metal Under Pressure. F. A. Halsey. Illustrates and describes the results of some experimental work. 1000 w. *Am Mach*—Nov. 22, 1900. No. 37731.

Foundry.

The Foundry of the General Electric Company at Schenectady, N. Y. C. L. Prince. An illustrated detailed description of a large foundry. 3000 w. *Jour Am Found Assn*—Vol. 14, Part I. No. 37524 C.

Fuels.

Cupola Fuels. Edward Kirk. An account of experiments made with gas and

liquid fuels, and charcoal fuel. 2200 w. *Foundry*—Nov., 1900. No. 37449.

Inspectors.

Shop and Mill Inspectors and Their Work. W. O. Henderer. The need of inspection is shown, and an account given of the methods adopted by the inspection department of the Osborn Engng Co., of Cleveland, O. 7500 w. *Jour Assn of Engng Socs*—Sept., 1900. No. 37446 C.

Jig.

A Drilling and Tapping Jig. Joseph V. Woodworth. Illustrated description of a jig for drilling and tapping a cast-iron hood. 600 w. *Am Mach*—Nov. 29, 1900. No. 37928.

Mixing.

Mixing Iron by Analysis. W. G. Scott. Describes the methods used in several large foundries making gray iron, malleable and steel castings, also brass and bronze work. 4800 w. *Foundry*—Nov., 1900. Serial. 1st part. No. 37450.

Molding.

Machine Molding. I. L. McCord. Read at meeting of the Foundrymen's Assn. Discusses some of these machines, their advantages and disadvantages, cost, etc. 4800 w. *Ir Age*—Nov. 8, 1900. No. 37573.

Molds.

Mold Construction for Crayons and Lead Balls. Joseph V. Woodworth. Illustrated description. 1400 w. *Am Mach*—Nov. 15, 1900. No. 37646.

Pyrometer.

A New Recording Air Pyrometer. William H. Bristol. Describes an instrument designed to measure temperature of high ranges, and to give continuous record of changes. 900 w. *Trans Am Soc of Mech Eng*s, No. 883—Dec., 1900. No. 37767 C.

Shop Equipment.

The Floor-Plate Portable Tool System of Handling Heavy Work at the Works of the General Electric Company. Illustrations and description, showing the utility of this system. 700 w. *Am Mach*—Nov. 29, 1900. No. 37927.

Steel Balls.

A New System for the Manufacture of Steel Balls. Illustrated description of the system used by the Steel Ball Company, of Chicago, for producing balls of any required size. 3300 w. *Am Mach*—Nov. 1, 1900. No. 37433.

Twisting.

A Twisting Operation. C. H. Rowe. Illustrates and describes the essential features of a recently constructed punch and die for twisting the ends of sheet metal. 700 w. *Am Mach*—Nov. 1, 1900. No. 37435.

Works Organization.

The Meaning of Commercial Organization of the Workshop. A. Hamilton Church. A discussion of the requisite basis of success under modern manufacturing conditions. 3500 w. Engineering Magazine—Dec., 1900. No. 37863 B.

Workshops.

Comfortable Work Shops. Editorial on the profitableness of keeping shops comfortably warm, well lighted, in good sanitary condition, etc. 1700 w. Ir Age—Nov. 8, 1900. No. 37575.

MATERIALS OF CONSTRUCTION.**Cast Iron.**

The Chemistry and Physics of Cast Iron. Continued discussion of Mr. Kreuzpointner's paper, entitled "Riddles Wrought in Iron and Steel." Ill. 8500 w. Jour Fr Inst—Nov., 1900. No. 37457 D.

Elastic Limit.

The Relation of the Elastic Limit to the Rupture of a Material (Welche Umstände Bedingen die Elastizitätsgrenze und den Bruch eines Materiales?). O. Mohr. A mathematical investigation of the conditions of rupture, discussing old and new theories and the deductions to be made from an observed elastic limit. Two articles. 8000 w. Zeitschr d Ver Deutscher Ing—Nov. 10, 17, 1900. No. 37845 each D.

Metals.

Hardness, or the Workability of Metals. W. J. Keep. Describes the machine constructed for testing, and gives examples of experimental work, with tabulated results. Ill. 3300 w. Trans Am Soc of Mech Engs, No. 879—Dec., 1900. No. 37763 C.

Note on the Structure of Phosphoretic Pig Metals. J. E. Stead. From Pro. Cleveland Inst. of Engs. An illustrated study of this metal. 700 w. Metallographist—Oct., 1900. No. 37770 E.

Paints and Varnishes.

The Composition and Classification of Paints and Varnishes. A. H. Sabin. A discussion of these substances, their various kinds and uses, and the considerations that should govern the choice and use. 1200 w. Trans Am Soc of Nav Archts & Marine Engs—Nov., 1900. No. 37663 D.

Specifications.

Specifications for Foundry Materials. Gives specifications used by the J. I. Case Threshing Machine Company of Racine, Wis. 5500 w. Ir Age—Nov. 1, 1900. No. 37440.

Specifications for Moulding Sand. Specifications under which the purchases for the J. I. Case Threshing Machine Co.

are made. 2000 w. Ir & Coal Trds Rev—Nov. 16, 1900. No. 37794 A.

The International Association for Testing Materials. Their discussion of proposed specifications at the meeting held Oct. 25, 26 and 27. 6800 w. Ir Age—Nov. 1, 1900. No. 37441.

Steel.

The Internal Architecture of Steel. J. O. Arnold. Read in the Mech. Sci. Section of the British Assn. for the Adv. of Science. An illustrated study of this subject. 2800 w. Metallographist—Oct., 1900. No. 37771 E.

Testing.

A New Method for Testing Materials (Nouvelle Méthode pour l'Essai des Matériaux). Ch. Frémont. A paper read before the International Congress for Testing Materials, describing the improvements of the author in the bending test. 7000 w. Revue de Mécanique—Oct. 31, 1900. No. 37806 H.

POWER AND TRANSMISSION.**Conveying.**

A Cableway Hoisting and Conveying Apparatus, with Traveling Electric Motor. Illustrated detailed description. 700 w. Eng News—Nov. 15, 1900. No. 37682.

Mechanical Conveyance of Coke in the Paris Gas Company's Works. M. Louvel. Read before the Gas Congress at Paris. Illustrated description of these mechanical arrangements. 5000 w. Jour Gas Lgt—Oct. 23, 1900. No. 37430 A.

Compressed Air.

A 150-Horse-Power Three-Stage Compressor. Description of a new type of compressor for carbonic acid gas, to work against a pressure of 1,200 lbs. 500 w. Eng Rec—Nov. 3, 1900. No. 37508.

Compressed Air for the Transmission of Power. J. H. Ronaldson. Read before the N. S. W. Chamber of Mines. Considers the laws affecting the compression of air, compressors, efficiency, methods of using and dangers. 3500 w. Compressed Air—Nov., 1900. No. 37590.

Gears.

A New Speed-Changing Gear. Illustrated description, with explanation of the principles upon which it works. 1300 w. Eng News—Nov. 15, 1900. No. 37688.

Mills.

Power and Power Transmission for Mills. Henry James Lamborn. The first of a series of articles on the supply of energy in the most efficient and economical manner. 1200 w. Mod Mach—Nov., 1900. No. 37565.

Moving Stairway.

A New Moving Stairway. Illustrated detailed description of the link-belt mov-

ing stairway, invented by J. M. Dodge. 700 w. Eng News—Oct. 18, 1900. No. 37546.

Traveling Stairways for the Elevated Railways, New York. Illustrates and describes details of a moving stairway being erected at the 23d St. Station of the 6th Ave. branch of the Manhattan Elevated system. 500 w. Sci Am—Nov. 17, 1900. No. 37651.

Rope Driving.

Rope Driving. H. J. Nichols. Read before the British Inst. of Draughtsmen. Brief discussion of the advantages and systems used. 1500 w. Prac Engr—Nov. 16, 1900. No. 37789 A.

Speed-Varying.

The Dieterich Speed-Varying Device. Illustrated description of the Dieterich gear, and some of its applications. 1800 w. Am Mach—Nov. 22, 1900. No. 37730.

SPECIAL MOTORS.

Banki Motor.

Experiments with the Banki Motor. E. Meyer. From the *Zeitschrift des Verein's Deutscher Ingenieure*. Illustrated description of the new form of the Banki motor. Also a comparison of the Diesel and Banki motors, with remarks on their application to motor vehicles. 4200 w. Auto Jour—Nov., 1900. Serial. 1st part. No. 37781 A.

Diesel.

Diesel's Motor at Paris. Extracts from a paper on recent tests of his engine, read by Mr. Diesel, giving comparisons of how it worked with various kinds of gas. 900 w. Am Mfr & Ir Wld—Nov. 22, 1900. No. 37769.

The Diesel Thermic Motor (Le Moteur Thermique Diesel). R. Diesel. A paper presented by the inventor at the International Congress of Mechanics at Paris, giving the most recent results and experiences with the Diesel motor. 6000 w. Revue de Mécanique—Oct. 31, 1900. No. 37807 H.

Gas and Oil.

Gas and Oil Engines. Discusses the fundamental principles, the cycle, gas engine performance, valve gear and governors, igniters, two-cycle engines, oil engine operation, etc., giving illustrated descriptions of numerous types. 25000 w. Power Quar—Oct. 15, 1900. No. 37919 C.

Gas Engines.

A New Principle in Gas-Engine Design. C. E. Sargent. Discusses the disadvantages of modern gas engines, and the writer's efforts to overcome these disadvantages, giving an illustrated description of the engine designed. 6800 w. Trans Am Soc of Mech Engs, No. 870—Dec., 1900. No. 37754 C.

Heat Efficiency of a Gas Engine as Modified by Point of Ignition. C. V. Kerr. An account of tests made in the gas engine laboratory of the Armour Inst. of Technology, with conclusions reached. 1600 w. Trans Am Soc of Mech Engs, No. 880—Dec., 1900. No. 37764 C.

I. Should a Gas Engine Be Compounded? E. W. Roberts. II. Successful Compounding Improbable. C. V. Kerr. III. Why It Is Unnecessary to Compound a Gas Engine. C. E. Sargent. A series of articles discussing the subject of compounding, both in theory and practice, with editorial. 4000 w. Mod Mach—Nov., 1900. No. 37504.

The Gas Engines at the Paris Exhibition. An illustrated review of the exhibits in this field. 6500 w. Power Quar—Oct. 15, 1900. No. 37918 C.

250 Horse-Power Gas Engine. An illustrated description of an exceptionally large gas engine. 900 w. Engr, Lond—Nov. 16, 1900. No. 37797 A.

Hydrocarbons.

Explosive Mixtures of Air and Hydro-Carbon Vapors (Sur les Mélanges Explosifs Formés par l'Air et par les Vapeurs des Hydrocarbures). J. Meuméur. An investigation of the best mixture of air and vapor for perfect combustion. 1000 w. Comptes Rendus—Oct. 15, 1900. No. 37817 D.

Motors.

See Mechanical Engineering, Automobile.

Secor Engine.

The Secor Internal Combustion Engine. Illustrated description of a single cylinder kerosene oil engine directly connected to a generator, all being mounted on a common base. 1100 w. Ir Age—Nov. 1, 1900. No. 37439.

STEAM ENGINEERING.

Blowing Engines.

See Mining and Metallurgy, Iron and Steel.

Boilers.

Comparison of Rules for Calculating the Strength of Steam Boilers. H. de B. Parsons. Calls attention to variations in the rules now in use, in the hope of eliciting a full discussion of the desirability of preparing a set of standard rules. 900 w. Trans Am Soc of Mech Engs, No. 876—Dec., 1900. No. 37760 C.

The Strength of Boiler Shells (Beitrag zur Festigkeitsberechnung der Kesselwände). W. Conrad. A theoretical investigation of the weakening effect of openings cut in boiler shells and the proper method of reinforcement. Two articles, 7000 w. Zeitschr d Oesterr Ing

u Arch Ver—Oct. 26, Nov. 9, 1900. No. 37816 each B.

Boiler Trials.

Boiler Trials and Analyses of Fuel and Chimney Gases. Abstract translation of a communication by H. Bunte, in response to a request for a set of rules for carrying out efficiency trials of boilers and steam-engines. 4500 w. Jour Gas Lgt—Oct. 30, 1900. No. 37593 A.

Tests of the Boiler of the Purdue Locomotive. W. F. M. Goss. Briefly describes the locomotive and its boiler, and the tests. Ill. 7200 w. Trans Am Soc of Mech Engs, No. 878—Dec., 1900. No. 37762 C.

Calorimeter.

A New Form of Calorimeter for Measuring the Wetness of Steam. John Goodman. Illustrated description of a new form of instrument designed by the author, and the method of using it. 2500 w. Prac Engr—Oct. 26, 1900. No. 37537 A.

The Steam Calorimeter. A. F. Nagle. Explains the principles upon which those in common use are designed, and their present development. Ill. 1600 w. Am Elect'n—Nov., 1900. No. 37485.

Central Valve.

An American Central Valve Engine. E. T. Adams. Describes the valve gear of an engine, the result of an effort to work the central valve idea in a form to meet existing conditions in America. 1800 w. Trans Am Soc of Mech Engs, No. 874—Dec., 1900. No. 37758 C.

Engine Specifications.

Specifications for Steam Engines. William H. Bryan. Letter on the best method of writing specifications for engines for any service. 1000 w. Eng Rec—Nov. 3, 1900. No. 37512.

Exhaust Pipes.

Exhaust Pipes for Condensing Engines. Discusses the faults in the design of exhaust pipes. 1000 w. Eng Rec—Nov. 7, 1900. No. 37773.

Exhaust Steam.

Heating Value of Exhaust Steam at Electric Stations. Alton D. Adams. A discussion of the various methods of utilizing the exhaust steam and so adding very materially to the present revenues. 3200 w. Elec Rev, N. Y.—Nov. 14, 1900. No. 37717.

Exposition.

Steam Engines at the Paris Exposition, 1900 (Die Dampfmotoren der Weltausstellung in Paris, 1900). A. Stodola. The first installment treats of the exhibits of Gebrüder Sulzer, of Zurich. 1800 w. 1 plate. Schweizerische Bauzeitung—Oct. 27, 1900. No. 37822 B.

Steam Engines at the Exposition of 1900. From *La Nature*. Brief summary of the striking peculiarities among the exhibits, with illustrations. 2700 w. Sci Am Sup—Nov. 17, 1900. No. 37653.

Feed Waters.

The Cold Purification of Boiler Feed Waters. Albert A. Cary. Discussion of N. O. Goldsmith's paper on the Water Softening Plant at the Lorain Steel Co.'s Blast Furnaces, read at the Cincinnati meeting of A. S. M. E. 1300 w. Power—Nov., 1900. No. 37455.

Fuel.

Liquid Fuel. E. L. Orde. Read before the N. E. Coast Inst. of Engs. and Ship-builders. Practical results of some experiments made by the writer, with conclusions. 2800 w. Col Guard—Nov. 16, 1900. No. 37902 A.

High-Speed.

A Record of the Early Period of High-Speed Engineering. Charles T. Porter. Reminiscences of John F. Allen, and of the infancy of high-speed steam engineering. 1400 w. Trans Am Soc of Mech Engs, No. 877—Dec., 1900. No. 37761 C.

High-Speed Steam Engine and Governor (Schnellaufende Ventildampfmaschinen und Flachregler). Fr. Freytag. An illustrated description of the Lentz high-speed steam engine, using poppet valves and shaft-governor. 4500 w. 1 plate. Zeitschr d Ver Deutscher Ing—Oct. 27, 1900. No. 37813 D.

Indicators.

Apparatus for Dynamically Testing Steam-Engine Indicators. Carleton A. Read. Illustrates and describes the apparatus and its use. 1300 w. Trans Am Soc of Mech Engs, No. 873—Dec., 1900. No. 37757 C.

Indicator Cards. Alfred Siebert. Explains how indicator cards show what is going on inside the cylinder. 3200 w. Ice & Refrig—Nov., 1900. No. 37513 C.

Marine Engines.

Modern Marine Engines (Moderne Schiffsmaschinen). R. J. Sanzin. A review of changes in design and proportion resulting from increase in speed and pressure. 3000 w. Schiffbau—Oct. 23, 1900. No. 37818 D.

Slide Valves.

Simple Slide Valves and Link Motions. J. Dowling. A solution of the various problems by graphical methods. Ill. 2000 w. Prac Engr—Oct. 26, 1900. Serial. 1st part. No. 37536 A.

Steam Turbine.

The Steam Turbine: The Steam Engine of Maximum Simplicity and of Highest Thermal Efficiency. Robert H. Thurston. A summary of the work of the steam

turbine to date, and a study of the sources of loss as it is now constructed and operated, and the principles of its correct design, construction and operation, with other related information. Ill. 18500 w. Trans Am Soc of Mech Eng, No. 881—Dec., 1900. No. 37765 D.

See Marine and Naval Engineering.

Valve Diagram.

The Application of Sweet's Diagram to the Meyer Valve. J. Begtrup. Explains the fundamental principles of cut-off valves, the Meyer cut-off diagram, and its limitations. 1600 w. Am Mach—Nov. 8, 1900. No. 37558.

Water-Tube.

Investigations Upon Babcock & Wilcox Boilers (Versuche an Babcock und Wilcox Kesseln). C. Züblin. Comparing the results of tests upon Babcock & Wilcox marine boilers with those of other types. 4000 w. Schiffbau—Nov. 8, 1900. No. 37819 D.

Water Tube Steam Generators for Naval Service. B. H. Thwaite. A very full discussion of the various types and their especial fitness for naval use. 6000 w. Engineering Magazine—Dec., 1900. No. 37860 B.

See Mechanical Engineering, Steam Engineering.

MISCELLANY.

Armor.

Armor and Guns. Ira N. Hollis. Historical review of ordnance development. 3500 w. Jour Worcester Polytechnic Inst—Nov., 1900. No. 37910 C.

MINING AND METALLURGY

COAL AND COKE.

Briquettes.

The Manufacture of Peat Briquettes (Ueber die Fabrikation von Torfbriketts). Dr. B. Kosmann. Discussing principally the value of compressed peat as fuel, including the cost of manufacture into briquettes. 3000 w. Glückauf—Nov. 3, 1900. No. 37828 B.

Coal-Cutting.

Mechanical Coal-Cutting in America. M. A. Bachellery. From a paper prepared for the Congress at Paris. Illustrates and describes machines and considers the results. 4300 w. Col Guard—Oct. 26, 1900. No. 37525 A.

Coke Oven Gas.

See Gas Engineering.

Coking.

The New Klondike Coking Field, Pennsylvania. William Gilbert Irwin. Brief account of one of the most important new

Contracts.

Letting Contracts Without Competition. An editorial discussion of the subject as illustrated by the armor-plate contracts. 2200 w. Eng News—Nov. 22, 1900. No. 37924.

The Construction of Contracts. Reginald Pelham Bolton. Suggestions designed to lead to the preparation of a more suitable form of contract than is now usually available. 3800 w. Trans Am Soc of Mech Eng, No. 885—Dec., 1900. No. 37768 C.

Integrator.

A Mechanical Integrator Used in Connection with a Spring Dynamometer. Max H. Wickhorst. Illustrated description of an integrator designed by the author for use in the dynamometer car of the C. B. & Q. R. R., for the purpose of showing the average drawbar pull. 600 w. Trans Am Soc of Mech Eng, No. 885—Dec., 1900. No. 37759 C.

Rifle.

The Lee Straight-Pull Magazine Rifle. E. G. Parkhurst. Illustrated description, with statement of the advantages claimed for the straight pull system. 2500 w. Am Mach—Nov. 22, 1900. No. 37729.

Velocity.

Velocity Diagrams. Dexter S. Kimball. Gives a method of finding the velocity diagram, and its value in machine design. Ill. 2500 w. Sib Jour of Engng—Nov., 1900. No. 37732 C.

coke regions. 700 w. Eng & Min Jour—Nov. 3, 1900. No. 37466.

Fuel.

Brown Coal as Fuel. S. Linderoth. Information concerning the origin, varieties, structure, and heating value. 1200 w. Brick—Nov. 1, 1900. No. 37520.

The Fuel Problem of China and the Far East. F. Lynwood Garrison. Information concerning the coal fields, the imports of coal, cost, consumption, etc., and the relation of other countries. 2800 w. Ir Age—Nov. 8, 1900. No. 37572.

Illinois.

Coal Mines at Streator. A. Dinsmore. An interesting illustrated description of the important coal fields and mines in La Salle County, Illinois. 2300 w. Mines & Min—Nov., 1900. No. 37408 C.

India.

An Indian Colliery and Its Miners. Henry M. Cadell. Notes on a visit to the

Karharbari colliery in Lower Bengal, 206 miles northwest from Calcutta. 3500 w. Trans of Min Inst of Scotland—June 9, 1900. No. 37654 D.

Paris Exhibition.

Bethune Colliery at the Paris Exhibition. An illustrated account of the exhibit of this colliery, with a review of its history. 3300 w. Col Guard—Nov. 9, 1900. No. 37709 A.

Lens Collieries at the Paris Exhibition. An account of the exhibit made by one of the most important French collieries, showing the appliances used and methods of working. 4000 w. Col Guard—Nov. 16, 1900. No. 37903 A.

Loire Collieries at the Paris Exhibition. Describes the exhibits of these collieries. 2800 w. Col Guard—Oct. 26, 1900. No. 37526 A.

Production.

The Question of Coal (Zur Kohlenfrage). A review of the question of coal consumption and production, with especial reference to Germany. Glückauf—Oct. 27, 1900. No. 37827 B.

Review.

Annals of Coal Mining and the Coal Trade. Robert L. Galloway. The present article reviews the period from 1836 to 1850, in England. 3500 w. Col Guard—Oct. 26, 1900. No. 37527 A.

Sakhalin.

The Coal Mines of the Island of Sakhalin (Der Steinkohlenbergbau auf der Insel Sachalin). F. F. Kleye. An account of the important developments of coal in the island of Sakhalin in the sea of Okhotsk at the mouth of the Amoor. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 10, 1900. No. 37825 B.

United Kingdom.

The Output, Value and Distribution of Coal During 1899. Information from the General Report dealing with the output and value of the minerals and metals of the United Kingdom. 3300 w. Col Guard—Nov. 9, 1900. No. 37710 A.

COPPER.

Idaho.

The Deepest Mine in Idaho. Describes the Ramshorn mine of Bayhorse, in Custer County, the deepest and best developed copper-silver mine in the State. 4000 w. Mines & Min—Nov., 1900. No. 37413 C.

Lake Superior.

Lake Superior Copper Mining. Horace J. Stevens. Facts in regard to the enormous production of the region and the large returns in dividends. 2200 w. Mines & Min—Nov., 1900. No. 37411 C.

New Mexico.

The Santa Rita Copper Mines, New Mexico. W. C. Potter. Brief historical account, with illustrations. 500 w. Eng & Min Jour—Nov. 17, 1900. No. 37724.

Separation.

The Volumetric Estimation of Copper as the Oxalate, with Separation from Cadmium, Arsenic, Tin and Zinc. Charles A. Peters. Shows that moderate amounts of copper may be determined quantitatively as the oxalate by precipitation with oxalic acid and titration of the precipitate by potassium permanganate, and also that moderate amounts may be separated from other metals in the presence of nitric acid, by the addition of oxalic acid. 2500 w. Am Jour of Sci—Nov., 1900. No. 37451 D.

GOLD AND SILVER.

Alaska.

Some Notes on Alaska. W. M. Courtis. Observations made on a recent trip in the Ketchikan district and as far as Bennett Lake. 1000 w. Eng & Min Jour—Nov. 10, 1900. No. 37598.

Cement Gravels.

Successful Working of Cement Gravels. G. E. Bailey. Concerning the difficulty in extracting the gold from the "blue gravels," and the success recently attained. Ill. 1300 w. Min & Sci Pr—Oct. 27, 1900. No. 37464.

Fissure-Veins.

Metasomatic Processes in Fissure-Veins. Waldemar Lindgren. The object of this review is to collect data relating to the alteration of rocks near or between fissures; to indicate the principal active processes; classify the veins, and give conclusions. Ill. 37500 w. Trans Am Inst of Min Engs—Feb., 1900. No. 37627 D.

Free Milling.

Free Gold Milling. W. Muir Edwards. Read before the Applied Science Soc. of McGill Univ. Describes the process from the ore to the bar. 4300 w. Can Engr—Nov., 1900. No. 37631.

Gold Fields.

History of the Southern Appalachian Gold Field. Theo. F. Van Wagenen. Ill. 1400 w. Min Rept—Nov. 8, 1900. No. 37634.

Hydraulic Mining.

Centrifugal Sluicing. A. J. Bensusan. From the *Jour. of the N. S. W. Chamber of Mines*. Describes this process of mining gold from auriferous gravel, giving information concerning work done. 3300 w. Can Min Rev—Oct. 31, 1900. No. 37437 B.

Leadville.

The "Down Town" mines of Leadville. Arthur Lakes. An illustrated account of

their development and the changing of Leadville from a silver to a gold mining camp. 4000 w. Mines & Min—Nov., 1900. No. 37409 C.

Quartz Mining.

Quartz Mining at Sarela, Central Siberia. An account of a visit to this locality and a favorable report of conditions of labor and mining prospects. 1300 w. U. S. Cons Repts, No. 893—Nov. 22, 1900. No. 37735 D.

Smelting.

Pyritic Smelting in the Black Hills. Franklin R. Carpenter. An account of experimental work. 4800 w. Trans Am Inst of Min Engs—Aug., 1900. No. 37-626 D.

Telluride-Ores.

The Telluride-Ores of Cripple Creek and Kalgoorlie. T. A. Rickard. Describes these ores and those associated, their treatment, etc. 3500 w. Trans Am Inst of Min Engs—Aug., 1900. No. 37-623 D.

IRON AND STEEL.

Blowing Engines.

Blowing Engines. William E. Snyder. Historical sketch of blowing machines used for iron smelting and for the Bessemer process. Ill. 10000 w. Pro Engrs' Soc of W Penna—Sept., 1900. No. 37-912 D.

British Columbia.

The Iron Ores of British Columbia. H. Mortimer Lamb. A fully illustrated account of the development of a new industry on the Pacific coast of America. 3000 w. Engineering Magazine—Dec., 1900. No. 37864 B.

Deterioration.

Influence of Copper in Retarding Corrosion of Soft Steel and Wrought Iron. F. H. Williams. Brief report of investigations made to find out what influence the presence of copper might have. 500 w. Pro Engrs' Soc of W Penna—Sept., 1900. No. 37913 D.

Early Enterprises.

Early Iron Enterprises in Cambria, Somerset, Westmoreland and Indiana counties, Pa. James M. Swank. Historical summary, giving facts of interest. 500 w. Am Mfr & Ir Wld—Nov. 1, 1900. No. 37478.

India.

The Iron Ores of India. An interesting article on the mineral industries of India, their early success, and the causes of the present unimportant position of the country in the production of this metal. 4700 w. Col Guard—Nov. 16, 1900. No. 37-900 A.

Iron Prospects.

The Revival and Reaction in Iron. Archer Brown, in *The Forum*. History of the sudden rise and fall of the past two years, and the outlook for the future. 4400 w. Am Mfr & Ir Wld—Nov. 8, 1900. No. 37628.

Iron Trade.

The Iron Trade of the Leading Countries of the World. Statistical and other information relating to the recent development of the iron and steel trade of the world. The present article is a general survey of the existing situation. 4500 w. Ir & Coal Trds Rev—Nov. 16, 1900. Serial. 1st part. No. 37793 A.

Mesabi.

The Mesabi Range. Cyril Brackenbush. An illustrated description of the ore and also of the open pit, the caving and the milling methods of mining. 3000 w. Mines & Min—Nov., 1900. No. 37410 C.

Norway.

Norway as an Iron-Producing Country. (Norwegen als Eisen Erzeugendes Land). Otto Vogel. A review of the iron production of Norway, and a discussion of its future development. Serial. Part I. 4000 w. Stahl und Eisen—Nov. 15, 1900. No. 37854 D.

Progress.

The Progress of the Iron and Steel Industries. Leyshon D. Thomas. Extracts from a presidential address delivered before the So. Staffordshire Ir. & Steel Inst. 4500 w. Col Guard—Nov. 2, 1900. No. 37616 A.

Steel.

See Mechanical Engineering, Materials.

Steel Exports.

Steel Rail Prices and Freight Rates on Steel Exports. Editorial, discussing the present situation between the steel-makers and railway companies in the United States. 1800 w. Eng News—Oct. 18, 1900. No. 37544.

Steel Plant.

The Dominion Iron & Steel Company, Limited. Illustrated detailed description of this plant at Sydney, C. B., and related matter. 4800 w. Ir Age—Nov. 8, 1900. No. 37574.

MINING.

Accidents.

Fatal Accidents in Coal Mining in North America. F. L. Hoffman. Reviews the period 1890-1899 for the United States and Canada, with comments. 1300 w. Eng & Min Jour—Nov. 24, 1900. No. 37752.

Boring.

New Systems of Boring (Ueber Einige Neue Bohrsysteme). W. Wolski. The

method includes the use of a reciprocating hydraulic motor operating the tool and capable of being lowered with the latter down the bore hole. 3000 w. Glückauf—Oct. 27, 1900. No. 37826 B.

Explosion.

The Explosion at the Red-Ash Colliery, Fayette County, West Virginia. W. N. Page. Gives results of an examination to determine the extent and cause of the explosion that occurred March 6, 1900, destroying much property and many lives. 3500 w. Trans Am Inst of Min Eng—Aug., 1900. No. 37622 D.

Ignition.

The Ignition of Mining Blasts by Accumulators (Accumulator-Minenzündung). J. von Lauer. A description of the use of the accumulator for igniting blasts in gaseous mines with a minimum of danger of firedamp explosions. 1200 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 20, 1900. No. 37823 B.

Lining.

Lining the Mine Gallery at Gardanne. G. Leugny, in *La Revue Technique*. Illustrates and describes the work, materials used, etc. 700 w. Col Guard—Nov. 2, 1900. No. 37614 A.

Measuring Drift.

A Method for Obtaining the Volume of Small Drifts and Working-Places, Where It Is Impossible to Use a Transit. C. S. Herzig. States the conditions and describes method. 1200 w. Trans Am Inst of Min Eng—Aug., 1900. No. 37624 D.

Mining Law.

The Principles of Mining Law. Charles J. Alvord. Abstract of a paper read before the Inst. of Min. & Met., in London. Reviews briefly the law of the more important countries of the world. 3200 w. Eng & Min Jour—Nov. 17, 1900. No. 37725.

Mining Plant.

See Electrical Engineering, Power Applications.

Props.

Tapered Props and Bars. W. Hutton Hepplewhite. Read at Derby meeting of the Inst. of Min. Engs. Illustrated description of patent tapered pit props and bars, with a statement of the advantages claimed for them. 700 w. Col Guard—Nov. 16, 1900. No. 37901 A.

Quarrying.

Quarrying by the Helicoidal Wire. N. Pellati. From a paper prepared for the Congress at Paris. Explains this method of cutting and its advantages. 1000 w. Stone—Oct., 1900. No. 37560.

Safety Appliances.

On Safety Appliances and Precautions

Necessary in Mines. J. R. Godfrey. Read before the Aust. Inst. of Min. Engs. Reviews the precautions which should be adopted to minimize the dangerous factors. Ill. 6500 w. Can Min Rev—Oct. 31, 1900. Serial. 1st part. No. 37438 B.

Shafts.

Deepening the No. 2 Shaft of the Rheinelbe and Alma Colliery. Illustrates and describes work attended with exceptional difficulty, as other uses of the shaft could not be interrupted. 2800 w. Ir & Coal Trds Rev—Nov. 9, 1900. No. 37712 A.

Headgear and Winding Engines for Deep Shafts. Léon Poussigue. From a paper read at the Paris Congress. Illustrated discussion of the winding engine, headgear, detaching hooks, etc. 3500 w. Col Guard—Nov. 2, 1900. No. 37613 A.

Survey.

A Mining Survey. J. F. Wilkinson. Description of a survey made in June, 1890, for the San Francisco shaft of the New Almaden quicksilver mines, which required great accuracy. 1800 w. Trans Am Inst of Min Eng—Aug., 1890. No. 37625 D.

Wire Rope.

Notes on Wire Rope (Einiges über Seildraht und Drahtseile). J. Divis. With especial reference to the manufacture and character of ropes for mining service. Serial. Part I. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 3, 1900. No. 37824 B.

MISCELLANY.

Analysis.

The Analysis of Uranium and Vanadium Ores. Oliver P. Fritchie. Directions for the determination. 800 w. Eng & Min Jour—Nov. 10, 1900. No. 37597.

High Temperatures.

Alumiothermic (L'Aluminothermic). L. Guillet. A discussion of the application of the Goldschmidt process of combustion of aluminum for the reduction of metals to the pure state. 3000 w. Génie Civil—Oct. 20, 1900. No. 37801 D.

Oil Fields.

The Oil Fields of Kern County, Cal. H. G. Parsons. Illustrated account of the Kern River district, reporting the development, quality of oil, value, and records of various companies. 4600 w. Min & Sci Pr—Oct. 27, 1900. No. 37463.

Ores.

Ore Buying. F. Danvers Power. Abstract of a paper read before the N. S. W. Chamber of Mines. Points on estimating, assaying, and methods in common prac-

tice. 1200 w. Ir & Coal Trds Rev—Nov. 2, 1900. No. 37620 A.

Platinum.

The Working of Platinum. John G. Niederer. Interesting facts regarding the peculiarities of this valuable metal. 900 w. Am Mach—Nov. 15, 1900. No. 37647.

Potassium Salt.

The Bleicherode-Sondershausen Potassium Salt Deposit. E. C. Mackay-Heriot. A description of this salt formation, giving profile near Munchen-Lohre, Germany. 900 w. Eng & Min Jour—Nov. 3, 1900. No. 37467.

Siberia.

The Future Possibilities of Siberia. On the resources of the country, especially its mineral deposits and methods of mining, and the effect the development will soon show. 3000 w. U. S. Cons Repts, No. 880—Nov. 7, 1900. No. 37534 D.

Zinc.

Some Changes in the American Zinc Industry. Editorial discussing the advantage gained by the natural-gas smelters in Kansas, and other matters of interest. 1100 w. Eng & Min Jour—Nov. 10, 1900. No. 37596.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

The Explosion of a Locomotive at Westerfield. An illustrated account of an unusual explosion on an English railway, and a study of the cause. 1300 w. Engr, Lond—Oct. 26, 1900. No. 37532 A.

Train Accidents in the United States in October. Detailed list and classified summary. 5000 w. R R Gaz—Nov. 23, 1900. No. 37948.

Checks.

The Elimination of the Brass Check. Abstract of paper by M. G. Carrel, presented at meeting of the Genl. Pass. Agts. Assn. An argument in favor of the substitution of the card for the brass check, and showing its advantages. 1400 w. Ry Age—Nov. 9, 1900. No. 37632.

Delays.

Train Delays. Condensed report on train delays, their causes, cost, responsibility for and remedies, presented at the Oct. meeting of the Pacific Coast Ry. Club. 3000 w. R R Gaz—Nov. 23, 1900. Serial. 1st part. No. 37750.

Fast Runs.

Fast Running on the Northern France. Report of a run from Arras to Paris. 450 w. R R Gaz—Nov. 16, 1900. No. 37671.

The Fast Camden-Atlantic City Trains. Facts and particulars concerning trains run by the Pennsylvania R. R. and the Philadelphia & Reading R. R. 3000 w. R R Gaz—Nov. 2, 1900. No. 37491.

Organization.

The Organization of a Great Railroad. Gives the organization of the Operating Department of the Southern Ry. 1400 w. R R Gaz—Nov. 9, 1900. No. 37603.

MOTIVE POWER AND EQUIPMENT.

Coaches.

New Coaches for "Black Diamond"

Express. Plan, illustrations and description of new cars for the Lehigh Valley R. R. 500 w. R R Car Jour—Nov., 1900. No. 37621.

Diamond Stacks.

The Passing of the Diamond Stack. Thomas P. Whelan. On the advantages of the old diamond stack as compared with straight stacks, and the reason of the change. 1000 w. Loc Engng—Nov., 1900. No. 37422 C.

Draft Gear.

Draft Gear and Couplers for Heavy Service. A letter from George Westinghouse, with editorial discussion of the subject. 1700 w. R R Gaz—Nov. 16, 1900. No. 37672.

Draft Gear—The Most Important Present Question in Car Construction. Report of trials of the Westinghouse friction draft gear, and the results. 1200 w. Am Engr & R R Jour—Nov., 1900. No. 37475 C.

The Drop Test as a Means of Showing Relative Strength of Draft Gears. R. P. C. Sanderson. Extracts from a paper before the Western Ry. Club. Gives an account of the A., T. & S. F. draft-gear drop tests, and points related. 1600 w. R R Gaz—Nov. 23, 1900. No. 37749.

Fireboxes.

Large Locomotive Fireboxes. A. Belmont. Compares an engine of ten years ago with one of recent date, and discusses the influence on combustion. 1500 w. Am Engr & R R Jour—Nov., 1900. No. 37473 C.

Fuel.

Liquid Fuel for Locomotives. Extracts from a paper by James Holden, presented at the Paris Congress. 3000 w. R R Gaz—Nov. 2, 1900. No. 37492.

Grates.

Emancipation of the Grates. Editorial discussion of the importance of recent

changes in grate area. 1400 w. Am Engr & R R Jour—Nov., 1900. No. 37474 C.

Hopper Rigging.

An Inexpensive Hopper Rigging. Brief illustrated description of a simple and effective hopper rigging for use on double-bottom coal cars on the Central Railroad of N. Jersey. 500 w. Am Engr & R R Jour—Nov., 1900. No. 37477 C.

Locomotives.

Brooks Chautauqua Type Locomotive, B. C. R. & N. Ry. Illustrations, leading dimensions, and general particulars. 1500 w. Ry & Engng Rev—Nov. 24, 1900. No. 37920.

Four-Cylinder Compound Locomotives (De Glehn Type). Illustration of this type, with views of prominent railroad men, and notes giving results of work done by these engines. 2500 w. Transport—Nov. 9, 1900. No. 37705 A.

High-Speed Locomotive for International Express Service; Schneider & Co. Exhibit, Paris Exposition. An illustrated description of an interesting machine with many novel features. 1800 w. Eng News—Oct. 18, 1900. No. 37541.

Locomotive and Tender with Two Coupled Axles (Locomotives-Tenders à Deux Essieux Accouplés). F. Barbier. Description of the simple coupled tank-locomotive exhibited at Paris by Krauss, of Munich. 1800 w. 1 plate. Génie Civil—Oct. 27, 1900. No. 37809 D.

Locomotives for Russian State Railways. Particulars, with illustrations. 500 w. Engng—Nov. 9, 1900. No. 37693 A.

Locomotives for the New Zealand Government Railways. Illustrated description of the two most recent types adopted for the main-line service. 700 w. Engr, Lond—Nov. 9, 1900. No. 37697 A.

New Locomotives for the "Atlantic City Flyers." An account of this rapid service and the competition between the Pennsylvania R. R. and the Philadelphia & Reading R. R., with illustrated description of the latest locomotives built for the last named road. 2500 w. Engr, Lond—Nov. 9, 1900. No. 37696 A.

New York Central's Latest Express Engine. Illustrates and describes an eight-wheel locomotive for fast express service. 250 w. Loc Engng—Nov., 1900. No. 37420 C.

Notes on English and French Compound Locomotives. Charles Rous-Marten. Paper read before the Soc. of Eng., England. A review of the merits and demerits of compounding from the viewpoint of its practical value in regular service, with conclusions. 1700 w. Transport—Nov. 9, 1900. Serial. 1st part. No. 37704 A.

Performance of "Northwestern" Type Locomotives. Profile of the C. & N. W. Ry., with record showing sustained high

horse-power for a run of 138 miles, and indicator cards corresponding, with comments. 1300 w. Am Engr & R R Jour—Nov., 1900. No. 37468 C.

Simon's Express Ten Wheeler. Illustrates and describes a powerful ten-wheel passenger engine. 350 w. Loc Engng—Nov., 1900. No. 37421 C.

Some New Locomotives of the Plant System. Specifications and brief description, with illustrations. 500 w. R R Gaz—Nov. 2, 1900. No. 37495.

Superheaters and Steam Jackets for Locomotives. Drawings and notes concerning an experiment being tried in England by the Lancashire & Yorkshire Ry. 400 w. Am Engr & R R Jour—Nov., 1900. No. 37496 C.

The Distribution of Steam in the Cylinders of Compound Locomotives (La Distribution de la Vapeur dans les Cylindres des Locomotives Compound). A mathematical analysis of the action of the valve gear in the distribution of steam in compound locomotives, with numerous examples. 4500 w. Revue Technique—Nov. 10, 1900. No. 37843 D.

The Growing Diversity in Locomotive Designs. Reviews the efforts made toward uniformity, and the causes that brought the movement into disfavor. 1000 w. Loc Engng—Nov., 1900. No. 37423 C.

Twelve-Wheel Wide-Firebox Freight Locomotive. Illustrates and describes a locomotive designed to burn bituminous slack in a fire-box extending over the rear driving wheels, the construction being such as to bring the engineer and fireman together in the same cab. 500 w. Am Engr & R R Jour—Nov., 1900. No. 37471 C.

Two-Cylinder Compound Locomotive for the North-Eastern Railway of Switzerland. Illustrated description. 600 w. Engng—Nov. 16, 1900. No. 37905 A.

Wide Fire-box Freight Locomotives for the Chicago & Eastern Illinois. Illustrates and describes one of the wide fire-box, compound, 12-wheel freight locomotives which will burn bituminous coal. 600 w. R R Gaz—Nov. 16, 1900. No. 37670.

See Street and Electric Tramways.

Motive Power.

What Motive Power Officers Consider Important. Report of interviews with progressive men. 2000 w. Am Engr & R R Jour—Nov., 1900. Serial. 1st part. No. 37469 C.

Railway Wagons.

Capacity of Railway Wagons as Affecting Cost of Transport. J. D. Twinberrow. Discusses the possible saving by employing vehicles of greater earning capacity, and the difficulties that stand in

the way. Ill. 6300 w. Inst of Mech Eng—Nov. 16, 1900. No. 37792 D.

Sleeping Cars.

Pullman Sleeping Cars for the Midland Railway. Illustrated description of fine cars for the Scotch service. All berths are on a level, the upper berths having been abandoned. 500 w. Engng—Nov. 9, 1900. No. 37692 A.

Smokeboxes.

Some Modern Locomotive Smokeboxes: Their Blast Pipes and Fittings. G. Willans. Illustrated description of various modern arrangements. 1400 w. Prac Engr—Nov. 9, 1900. No. 37702 A.

Smokeless Combustion.

Smokeless Combustion in Locomotive Fireboxes. A. Bement. Abstract of a paper presented before the W. Ry. Club. Treats of details of the combustion process. 1200 w. Eng News—Oct. 18, 1900. No. 37547.

Steel Cars.

Steel Flat Cars, 100,000 Pounds Capacity. Drawings and description of cars for the N. Y. C. & H. R. R. R. 400 w. Am Engr & R R Jour—Nov., 1900. No. 37470 C.

Track Tank.

Track Tank Water Scoop. Illustrates and describes a design worked out by H. F. Ball for the L. S. & M. S. Ry. for use on fast passenger locomotives and also in freight equipment. The tests give a very satisfactory performance. 900 w. Am Engr & R R Jour—Nov., 1900. No. 37472 C.

Train Lighting.

The Electric Lighting of Railway Trains (L'Eclairage Electrique des Voitures de Chemin de Fer). A description of the method of the Compagnie Générale Electrique, using a dynamo driven by the axle, and operated in connection with an accumulator. 3500 w. Revue Technique—Oct. 25, 1900. No. 37811 D.

Valves.

Piston Valves. Wilson Worsdell. Illustrates and describes valves used by the North Eastern Railway of England. 900 w. R R Gaz—Nov. 12, 1900. No. 37493.

Wheels.

Cast-Iron Car Wheels. G. W. Beebe. Abstract of a paper presented before the W. Ry Club. Discusses the manufacture and testing of cast-iron wheels, with a comparative record of tests made by the writer, and recommendations which he thinks would lead to better results. Ill. 2200 w. Eng News—Oct. 18, 1900. No. 37545.

Wrecking.

Wrecking Outfit, Pennsylvania Lines West. An illustrated account of a very

complete wrecking outfit of the Pennsylvania Lines West, with editorial. 2700 w. Ry & Engng Rev—Nov. 3, 1900. No. 37567.

NEW PROJECTS.

Arkansas.

New Railroad Work in Arkansas. Information concerning work building and projected. 1700 w. R R Gaz—Nov. 9, 1900. No. 37607.

Boston & Albany.

The Absorption of the Boston & Albany by the New York Central. Editorial concerning the lease for 99 years about to be ratified. 1300 w. R R Gaz—Nov. 2, 1900. No. 37497.

China.

The German Railway in Shantung, China. H. L. Geissel. Brief description of the line now in process of construction. 600 w. Eng News—Nov. 29, 1900. No. 37936.

Mexico.

Railroad Building in Mexico. A review of roads building or under contract showing activity. 1800 w. R R Gaz—Nov. 9, 1900. No. 37606.

Scotland.

The Connell Ferry and Ballachulish Railway. An account of a new railway in Scotland that will open a country of great beauty, as well as develop the resources of this region. 3000 w. Engr, Lond—Nov. 16, 1900. No. 37796 A.

Siberia.

Siberian Competition. An editorial discussion of Siberian conditions, with extracts from a series of articles by Dr. Kurt Widenfeld, in the *Archiv. für Eisenbahnwesen*. 2000 w. R R Gaz—Nov. 2, 1900. No. 37496.

PERMANENT WAY AND BUILDINGS.

Copenhagen.

The International Competition for the Rebuilding of the Passenger Station at Copenhagen (Der Internationale Wettbewerb für den Umbau des Personenbahnhofs in Kopenhagen). With plans of the prize-winning designs and a discussion of the proposed improvements. 1800 w. Schweizerische Bauzeitung—Oct. 20, 1900. No. 37821 B.

Grades.

Investigation as to Virtual Grades, Canadian Pacific Ry. A. C. Dennis. Diagrams, with explanation of their use. 1000 w. Eng News—Nov. 22, 1900. No. 37926.

Icing Plant.

New Icing Plant of the "Burlington Route" at Hannibal, Mo. Illustrated de-

scription. 450 w. R R Gaz—Nov. 23, 1900. No. 37745.

Rail Joints.

Broken and Square Rail Joints for Railway Track. Expressions of opinion concerning the use of the two methods, and the reasons for and against them. 1400 w. Eng News—Nov. 15, 1900. No. 37685.

Signals.

Automatic Electric Block Signals for Railways (Elektrisch Selbstthätige Block Signale für Eisenbahnen). L. Kohlfürst. Advocating the introduction of automatic signals, and describing the Sacek system. Serial. Part I. Elektrotech Zeitschr—Nov. 8, 1900. No. 37839 B.

Automatic Signal Locations. C. C. Rosenberg. Condensed paper read before Ry. Sig. Club, at St. Louis. Suggestions concerning methods of locating, and things to be avoided. 1200 w. R R Gaz—Nov. 2, 1900. No. 37494.

Some Questions About Progress and Uniformity in Signaling. B. B. Adams. Extracts from a paper read before the Ry. Sig. Club. 1000 w. R R Gaz—Nov. 9, 1900. No. 37604.

Station.

Passenger Station of the Southern Railway at Richmond. Illustrated description. 450 w. R R Gaz—Nov. 9, 1900. No. 37605.

Switches.

Split Switches. Extracts from a report presented before the Roadmasters' Assn.

of America. 900 w. Ry & Engng Rev—Nov. 24, 1900. No. 37921.

Terminal.

Locomotive Terminal of the French Eastern Railway at Noisy-le-Sec. Brief illustrated account of these buildings in the suburbs of Paris and their appointments. 1200 w. Ry & Engng Rev—Nov. 3, 1900. No. 37568.

The Terminal Improvements of the Chesapeake & Ohio Ry., at Richmond, Va. Illustrated description of work, including a long line of viaduct, and a new union station and train shed. 2200 w. Eng News—Nov. 29, 1900. No. 37937.

Ties.

The Preservation of Ties on the Southern Pacific Ry. Particulars as to the preservative treatment and the renewals of treated ties. 2500 w. Eng News—Oct. 25, 1900. No. 37551.

Transition Curves.

Transition Curves. J. H. Lory. Gives the writer's conclusions in spiraling track and the system used. 1200 w. Jour W Soc of Eng—Oct., 1900. No. 37418 D.

TRAFFIC.

Rates.

A Railway Freight Rate of 2 Mills Per Ton-Mile. Editorial discussion of the remarkable low rates. 1800 w. Eng News—Nov. 8, 1900. No. 37599.

The New German Railway Rates for the Carriage of English Coal Imports. An explanation of the condition of affairs at the present time. 1000 w. Col Guard—Oct. 26, 1900. No. 37528 A.

STREET AND ELECTRIC TRAMWAYS

Accounting.

The Routine of a Railway, Electric and Gas Lighting Company. C. O. Simpson. Read at Kansas City Convention. Points relating to office methods. 2500 w. St Ry Jour—Nov. 3, 1900. No. 37490 D.

Car Bodies.

Painting, Repainting and Maintenance of Street Car Bodies. F. T. C. Brydges. Read at Kansas City Convention. A discussion of methods and report of cost. 2200 w. St Ry Jour—Nov. 3, 1900. No. 37489 D.

Car Heating.

Heating of Tramway and Light Railway Cars. M. C. de Burelet. Abstract of paper read at the Congress at Paris. Considers methods of heating. 1200 w. Tram & Ry Wld—Oct. 11, 1900. No. 37445 A.

Carlisle, Eng.

The City of Carlisle Electric Tramways. Illustrated detailed description of overhead construction system. 1600 w. Tram & Ry Wld—Oct. 11, 1900. No. 37442 A.

"Centrifugal" Railway.

A "Centrifugal" Railway for Pleasure Resorts. M. F. Brown. A brief illustrated description of a railway built at Rivers Beach, Mass. 1000 w. Eng News—Nov. 15, 1900. No. 37690.

Compressed Air.

Compressed Air for Street Railway Operation. H. D. Cooke. Read at meeting of N. Y. State St. Ry. Assn. Briefly describes the construction and operation of the air car. 2500 w. Compressed Air—Nov., 1900. No. 37588.

Compressed Air Traction in New York

City. A summary of the recent developments of this mode of traction in New York City. Ill. 2500 w. R R Gaz—Nov. 23, 1900. No. 37746.

Compressed Air Locomotives. H. K. Myers. Considers principles governing their construction, and gives some of the reasons why they are often preferred in mines. Ill. 2500 w. Mines & Min—Nov., 1900. No. 37414 C.

Report on the New Hardie Air Motor Cars Now in Use on the 28th and 29th Street Line, New York City. W. L. Hoffecker. Letter giving favorable report of inspection. 1200 w. Compressed Air—Nov., 1900. No. 37589.

Consolidation.

Consolidation of Street Railways and Its Effect Upon the Public. Daniel B. Holmes. Read at Kansas City Convention. Shows that such consolidation brings benefits to the public as well as to the companies. 2000 w. St Ry Jour—Nov. 3, 1900. No. 37487 D.

Contact System.

Electro-Magnetic Contact System for Tramways (Elektromagnetisches Kontaktsystem für Elektrische Bahnen). J. P. Doflein. A description of the Stobrawa system, used by the Helios Company. 2500 w. Elektrotech Zeitschr—Nov. 8, 1900. No. 37838 B.

The Schuckert Contact System of Electric Traction. Illustrated detailed description of the improved system as introduced in Munich. 1900 w. Elec Engr, Lond—Nov. 16, 1900. No. 37786 A.

Cross-Country System.

The Exeter, Hampton & Amesbury Street Railway. C. B. Fairchild. Illustrated detailed description of interesting lines through a very attractive region. 3700 w. St Ry Rev—Nov. 15, 1900. No. 37713 C.

Distribution.

Comparisons of the Various Systems of Electrical Distribution for Street Railways. C. F. Bancroft. Read at Kansas City Convention of Am. St. Ry. Assn. Discusses the six systems at present in use, and the need of selecting the system best suited to the conditions. 3000 w. St. Ry Jour—Nov. 3, 1900. No. 37488 D.

Double Trucks.

Double Truck Cars: How to Equip Them to Obtain Maximum Efficiency Under Varying Conditions. N. H. Heft. Discusses trucks, electric motors, and double truck car body and equipment. Followed by general discussion. 8800 w. St Ry Rev—Nov. 15, 1900. No. 37715 C.

Electrolysis.

Electrolysis in Reading, Pa. Illustrated extracts from a report by A. A. Knudson, on an electrical survey of the

water mains in Reading, the interlacing of street tracks introducing some special features. Also editorial note on the danger of stalling cars at railroad crossings. 4500 w. Eng Rec—Nov. 10, 1900. No. 37585.

Funicular Road.

The Malberg Railway at Ems (Die Malbergbahn bei Ems). R. Schaar. Illustrated account of this double cable road, operating up grades of 54 per cent., on the Malberg, near the watering place of Ems. 1800 w. Ill. Zeitschr f Klein u Strassenbahnen—Nov. 1, 1900. No. 37842 D.

Locomotives.

Accumulator-Driven Locomotives for Workshops (Ueber Fabrik locomotiven mit Accumulatorenbetrieb). Max Büttner. Illustrating and describing a number of electric locomotives used in manufacturing establishments in Germany, and showing the advantages of accumulators for such service. 2500 w. Stahl und Eisen—Nov. 1, 1900. No. 37853 D.

Standard Gauge Electric Locomotive (Elektrische Vollbahn-Locomotive). Illustrated account of the powerful electric locomotives for standard gauge service, built by the Allgemeine Electricitäts Gesellschaft, of Berlin. 3000 w. Mitt d Ver f d Förd d Local u Strassenbahnwesens—Oct., 1900. No. 37851 D.

London Railway.

The Central London Railway. An illustrated account of this underground railway and its equipment. 7400 w. Tram & Ry Wld—Nov. 8, 1900. No. 37939 A.

Moulineaux Station.

The Moulineaux Traction Station at Paris. Illustrated description of the largest electrical generating station in France. 1100 w. Tram & Ry Wld—Oct. 11, 1900. No. 37443 A.

Rack Railway.

A Rack Railway on the Island of Sumatra. Illustrated description of a line used almost exclusively for the transportation of bituminous coal. 400 w. Sci Am—Nov. 3, 1900. No. 37427.

Rail Joints.

The Falk Cast-Welded Rail Joint on European Street Railways. Concerning the advantages of the cast-joint over the electrically welded joint, and the use as reported by tramway companies. 800 w. Eng News—Nov. 15, 1900. No. 37684.

Rapid Transit.

Progress of Work on the Rapid Transit Tunnel, New York. Views, showing the plant and method of construction, with explanatory notes. 1500 w. Sci Am—Nov. 24, 1900. No. 37740.



VOL. XX.

FEBRUARY, 1901.

No. 5.

RUSSIA'S SYSTEM OF INTERNAL WATERWAYS.

By Alexander Hume Ford.

WITH EDITORIAL INTRODUCTION.



PARALLEL has been suggested, not inaptly, between the development Russia is undergoing to-day and that which marked the industrial history of the United States during the past century. Unlike as are their political systems, the economic positions of the two lands present a good many features in common—each a region of vast territorial extent, singularly rich in fertile soils and mineral deposits, changing rapidly from purely agricultural to largely industrial occupations under the influence of ideas and agencies coming from without.

Russia's political condition has kept her in isolation almost as great as that which geographical conditions imposed upon the United States. In her new awakening, and in the exploiting of her natural resources, like the new world she has opened avenues for the capital, energy, and engineering skill of countries farther advanced industrially. The movement has been more rapid—more dramatic—because highly developed machinery and fully tested methods stood at her very doors, ready for instant application, while the exploitation of the American continent in a great measure proceeded *pari passu* with the evolution of the machinery of transport and of industrial production.

In this material upbuilding, the first process is the development of

Copyright, 1900, by John R. Dunlap.

transportation. It was the great natural waterways of the central States that opened the country to the sweeping flood of civilisation. The Ohio and Mississippi in America—the Volga, the Don, the Dneiper, the Kama in Russia—serve to the interior of those vast tracts as the sea served to England or to ancient Greece, that is, to make a plain road for traffic and exchange with distant markets. Water transport, bringing in heavy machinery and supplies, bearing out great bulk of products, moving population and materials smoothly and cheaply from point to point—this is the great fostering agency in the early stages of the making of an industrial and commercial empire. Later comes the railway, meeting conditions attending the progress of settlement and development of the country, to which water transport is no longer adequate. But the river and the canal are pioneers, pathfinders, promoters, and faithful coadjutors of the railway. It is to the internal waterways of Russia, therefore—to the natural advantages with which the country is remarkably endowed and to their well-devised improvement and extension—that the first of Mr. Ford's articles on Russian industrial conditions and opportunities is devoted.—THE EDITORS.

THE canal system connecting the waterways of Russia with each other and with those of Europe may be said to have had its inception at the little town of Zaandam, in Holland, where Peter the Great served his apprenticeship as a ship-builder and incidentally became impressed with the value of inland waterways.

In his early youth this indefatigable worker began laying plans for the commercial development of his domains. Before he became Tzar he had organized a Board of Water Communications in Russia, of which he was the first chief. When he had founded the city which bears his name, the Great Tzar turned, with his own hand, the first spadeful of earth from the canal which was to bring the capital on the banks of the Neva into communication by water with the most distant parts of his empire, the Arctic Ocean to the north, the Caspian to the south, and the borders of Asia to the east, while westward lay all Europe, with its system of inland waterways then in process of development.

For more than one hundred years after the commencement of Peter the Great's life work the waterways were the only practical means of cheaply transporting the products of Russian soil and industry from one part of the vast domain to another. No other

country is so prodigally endowed with navigable rivers. In European Russia alone fully 60,000 miles of inland waterway were navigable to the simple barges of those days. The rivers of Russia have their sources within a comparatively few miles of each other, all of the great streams rising within the area of the broad plateau of the north, so that it was no difficult feat to connect the headwaters of the numerous rivers. The construction of less than 4,000 miles of canals and canalized rivers, of less than 900 miles of actual canal, made it possible to



WHARF ON ALEXANDER III. CANAL, ST. PETERSBURG, WITH SEA-GOING SHIPPING.

travel by barge from Archangel, on the Arctic, to Astrakan on the Caspian, a distance of more than 3,000 miles, from St. Petersburg to the foot of the Urals, and from the Baltic to the Black sea by three distinct routes, to say nothing of Moscow and numerous other inland cities which were brought into direct water communication with all parts of the empire.

The consolidation of Russia was brought about chiefly by means of its waterways. Before the Christian era Greek fleets ascended the streams flowing into the Black Sea from northern Muscovy. Later the Slavonic armies floated down those rivers on rafts and barges to expel the Golden Horde. Almost in our own times the Turks have been expelled from the deltas of Russia's southern rivers, while in the last two centuries bands of armed adventurers, by following the natural waterways across Siberia, have carried the banners of the



ST. PETERSBURG FROM ACROSS THE NEVA.

Tzar beyond Lake Baikal, completing in our own day the conquest of Siberia by means of flotillas on the Amur, to say nothing of events even now taking place on the Sungari River, in Manchuria, which is being used as a military base, along which munitions of war and railway material can be quickly conveyed from place to place.

For a century the network of waterways in European Russia amply served the needs of the peasants who cultivated the farms on the river banks, but with the coming of the railway a new order of commercial life sprang into existence. Russia began to merge from the primitive, her population increased by leaps and bounds, until it now exceeds 100,000,000. Cities sprang up along the lines of rail and for more than fifty years the improvement of waterways was all but neglected. The railroad alone was to be the means of regenerating commercial Russia, but with the advent of Prince Hilkoﬀ, fresh from his apprenticeship in America, as chief of the rail and water systems of Russia, a change was announced. It has been decided that the railroads of Russia are to be auxiliary to a more perfect system of inland communication, which is to be the feature of the twentieth century. Old canals are to be rebuilt on a larger scale, and colossal projects are being considered for perfecting the inland system of waterways so that they may be used in connection with the railroads, each acting as a feeder of traffic to the other.

The greatest project at present under discussion in Russia is the

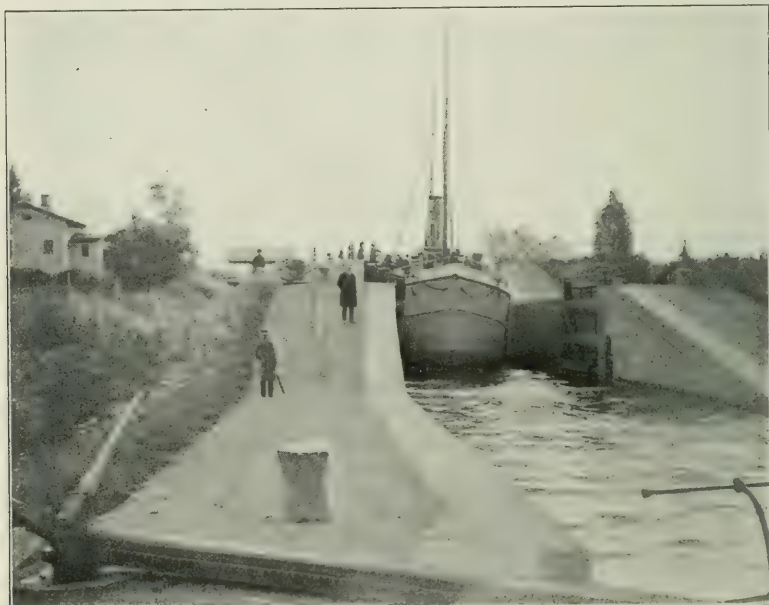
Baltic-Black Sea ship canal. The plan was first suggested by a syndicate of Belgian and French engineers who wished to build and control the canal, but the government would listen to no project granting a private concession. The syndicate then offered, for the sum of \$700,000,000 to cut a 28-foot channel from the Baltic to Kherson, on the Dneiper, giving a waterway from sea to sea, a distance of nearly 2,000 miles, deep enough to float the heaviest battle-ships in the Russian navy.

This wonderful canal, which, when built, will put all of earth's other engineering achievements in the shade, is but a beginning of Russia's projects for perfecting an inland water system evidently destined to make her the greatest commercial nation of the world, if carried to completion. The narrow peninsula connecting the Crimea with Russia is to be cut through, thus bringing Odessa and the sea of Azov hundreds of miles nearer each other. Already Sevastopol is declared a closed port and its merchants and shipping have deserted it for other cities. From the Sea of Azov a ship canal is to be dug to the Caspian Sea, thus bringing central Asia in direct steamship communication with America and the rest of the world. It is in southern Russia and Trans-Caspia that American commerce is increasing so rapidly as to give cause for serious alarm to the manu-



THE BEGINNING OF THE CANAL CONNECTING MOSCOW WITH THE NATURAL WATERWAYS.

facturers of Germany and England. Russian engineers who have closely watched every new invention made necessary to overcome difficulties encountered in the progress of the Chicago Drainage Canal express a belief that the cutting of a canal to unite the Black and Caspian Seas, with the use of American machinery, will not be an impossible task. A company has recently offered to complete the

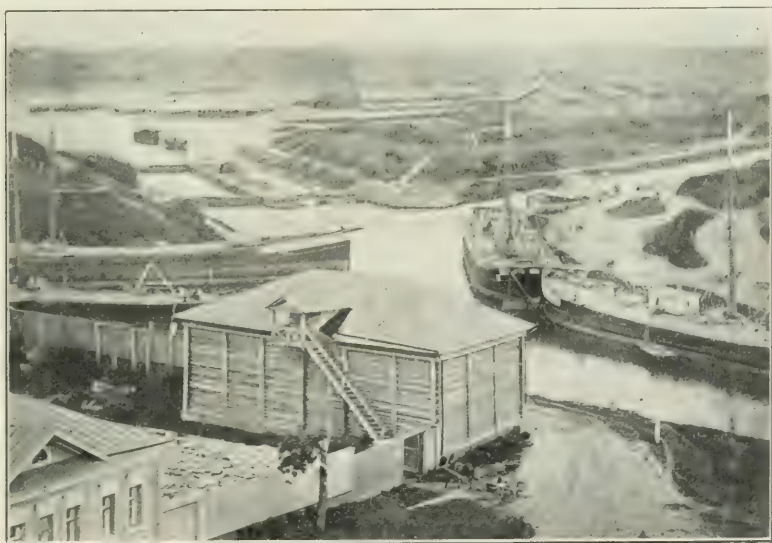


LOCK ON THE SAIMA CANAL, FINLAND.

work for the sum of \$40,000,000. In fact, numerous preliminary surveys have been made of suggested routes; nor was Peter the Great responsible for the first suggestion of a connection between the two seas. As far back as 1568 the Turkish Sultan Selim, desiring to get his fleet upon the Caspian Sea, where it could attack Persia, attempted to unite the waters of the Don and Volga at a point where they approach within a few miles of each other. The work was abandoned, however, to be taken up by the energetic Peter in 1701 and pushed vigorously, but for once the great monarch was baffled by the waters and he, too, reluctantly abandoned the project. The chief difficulty in the way of building a ship canal to connect the two seas is the shallowness of the river Don, for although steamers ascend its waters for a thousand miles to bring down the coal from the mines that open on its very banks, they have trouble at certain seasons in keeping off the sand bars even at the mouth of the river.

About the delta of the Volga the shores of the Caspian are low and swampy. Following one proposed route between the two bodies of water, the surface of the country rises to not more than 118 feet above the level of the Caspian, and but 33 feet above the Black Sea, so that a canal once cut would need locks only to prevent a too rapid flow of water, while a constant flow from the inexhaustible supply of the Mediterranean might in time cause an appreciable change in the level of the Caspian, extending its borders toward ancient limits and making the proposed plans for uniting it with the Sea of Aral more easy of accomplishment.

The construction of a canal connecting the Don and Volga rivers would complete an all-water route around European Russia just within its borders. The scores of steamers that ply between Archangel and St. Petersburg, continuing thence to Astrakan as they sometimes do even now, might return via the Dneiper route. Every year the depth and usefulness of the canals and waterways of Russia



THE MEETING OF FOUR CANALS, AT RYBINSK, ON THE VOLGA.

is increased: in 1842 the barges entering St. Petersburg through the waterways from the Arctic Ocean and the Caspian Sea were of no greater capacity than 160 tons; now craft carrying 1,000 tons and over easily pass through the locks, and with enlargements soon to be made even this capacity will be greatly increased. Everywhere up the Volga and its hundred tributaries ascend the iron barges of the Caspian Sea oil fleet, while through the canals to St. Petersburg

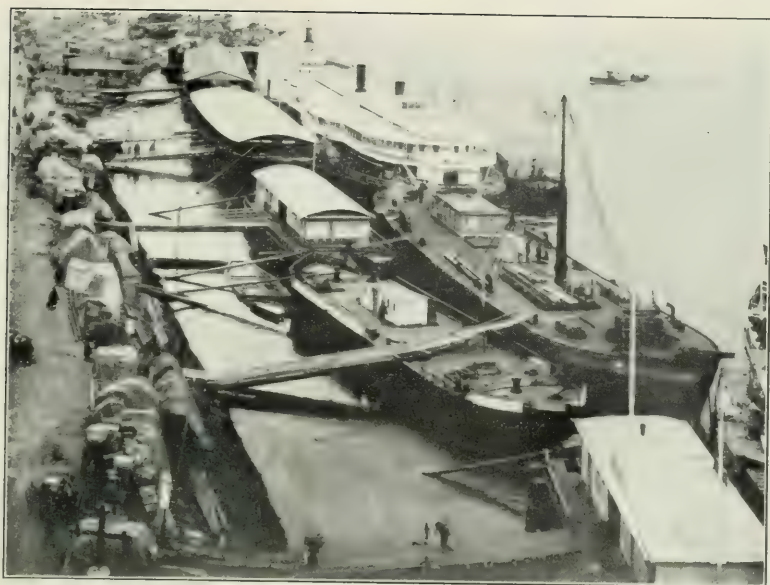
alone pass annually, during the 215 days of free navigation, thousands of steamers and barges bearing millions of tons of freight. Every known means of locomotion is used, from men, who, like oxen, tramp the two paths, hauling the smaller barges, to powerful tugs that creep along by means of a heavy chain laid in the beds of the canals and minor rivers, dragging after them at snail pace great caravans of heavy barges. From the greater streams immense craft nearly 400 feet long, 15 feet in depth, carrying 6,000 tons of freight, drift down to the Caspian, where they are broken to pieces to be used as fire-wood on the steamers going up stream. In all there are 8,000 miles



BARGE BEING HAULED UP A RUSSIAN RIVER BY A HEAVY ROPE.

The rope or chain is laid in the river bed and is picked up by the steamer, passed over a revolving winding drum, and dropped astern, thus giving a slow haulage. The same system is in use on the Rhine and other European rivers.

of navigable waterways in the valley of the Volga, or, if the streams which float the giant rafts that form so large a part of the traffic of the rivers are included, the mileage is increased to nearly 15,000, or as much as that of the valley of the Mississippi. Fifty thousand rafts are floated down the Volga annually, many of them 100 feet long by 7 thick, and this gives but a faint idea of the real traffic of the river; for in addition there are ten million tons of produce passing up and down the river during the open season. Much of this centres at Nijni Novgorod. To this famous market steamers and barges come from all parts of Russia, bringing goods to be sold at the great annual fair, over \$200,000,000 worth of merchandise changing hands in a



BARGES AT NIJNI-NOVGOROD.

The immense total of merchandise dealt in at the annual fair is transported largely by water.



CRAFT LAID UP FOR THE WINTER ON THE VOLGA.



ON THE MARIE CANAL BETWEEN ST. PETERSBURG AND THE VOLGA.



ABANDONED LOCKS ON A CANALIZED RIVER.

few weeks; 30,000 craft, including rafts, are required for this traffic; they come from as far north as Archangel, as far east as the Urals, from Astrakan in the south, St. Petersburg and Moscow to the west; while great caravans of ships of the desert arrive daily from all parts of Asia. Yankee methods are revolutionizing traffic on the Volga. American steamers modeled after the Mississippi floating palaces now ply every part of the river, cutting through the water at the rate of 20 miles an hour and burning petroleum refuse in place of coal. More than a thousand of these passenger and freight steamers are now in use on the Volga, some of them having been in commission since 1872. On the lower river great dredges, designed in Chicago and built on the model of the American Government boat *Beta*, the crack dredger of the Mississippi, are deepening the channel to the



A VOLGA RIVER STEAMER. STERN-WHEEL TYPE.

Caspian. These mammoth machines, with their great rotary suction pipes, have already proved so successful on the Volga that the Russian Government has decided to use them in other parts of the Empire and to maintain a much greater depth in the rivers than ever before contemplated. One of these dredges, built by the John Cockerill Company, of Seraing, Belgium, is now at work pumping a channel through the upper Caspian, where the waters are extremely shallow after certain winds. The railroad is being pushed to Astrakan, and with the completion of the new channel, the largest vessels of the oil fleet will unload at the railroad wharf instead of transferring cargo to light-draught vessels several miles out at sea.

Russia has projected greater things in Central Asia than in any other part of the Empire; not only are thousands of square miles of desert being reclaimed by irrigation and thus made the most productive land in the world, but the mighty Oxus is to be diverted from

its present bed to its ancient and deserted course, so that it will once more flow into the Caspian Sea. This river rises in India beyond the Pamirs, flowing for more than 1,500 miles to the Sea of Aral; its volume is three times as great as that of the Danube, and for the greater part of its length it is possible for large steamboats to navigate this famous river. Even at Charjui, where the Trans-Caspian Railway crosses it, the Oxus is as wide as the Mississippi at Memphis, and from this point to the borders of Afghanistan a regular line of Russian steamboats is maintained to carry passengers and freight back and forth. The Russian engineers have located the old bed of the Oxus and anticipate no difficulty in altering the present course of the stream, but as it is estimated that 25 years would elapse before the first drop of water would find its way across the thirsty desert of the Caspian, it is quite possible that advantage may be taken of the fact that the Sea of Aral is 200 feet higher than the Caspian, and a



BLOWING UP THE ICE TO OPEN NAVIGATION AT RIGA.

channel dug through the old bed of the gulf which once connected the two seas. And it may yet be made possible to travel by barge half way around the world, for Russia will not permit her plans in Siberia to be thwarted by the Urals, as her designs on India have been by the Pamirs. From St. Petersburg to Tcherdin, at the foot of the Urals, she sends her steamboats. From this point a canal will

some day find its way between the low hills to the level plains of Asia, scarce a hundred miles further on. In fact, a few years ago the mine owners in the Urals began the construction of such a canal, which would have given a direct navigable waterway from the Baltic to beyond Lake Baikal, but after a few miles of the canal had been built the Government ordered the work stopped, on the ground that it was



BANK-PROTECTION WORK ON A RUSSIAN RIVER.

Making and setting brush mats.

of too great importance to be undertaken as a private enterprise. The Government expects soon to make the necessary appropriation to complete this most important piece of engineering. For many years the available routes have been sought by the Government by which the rivers of Russia and Siberia could be connected. Already the Dwina is made tributary to the Kama, and it is hoped that in time the Petchora will also be united to this mighty stream, which, although but a branch of the Volga, is navigable for nearly 1,000 miles, and accommodates a traffic greater than that of the Mississippi. These northern rivers flowing into the Arctic Ocean are open to navigation but 100 days out of the year, yet they export half a million tons of produce annually, and so important is the port of Archangel considered that it is to be a terminus of the Trans-Siberian Railway, as well as of the great canal from Lake Baikal and beyond. For many years the Kama served as a part of the Trans-Siberian Railroad, and even previously convicts were sent by steamer and



PREPARING RAFTS OF LOGS ON THE UPPER KAMA.



RAFTING LOGS ON THE KAMA.

barge to its headquarters in the Urals and then marched overland through the low valleys to the Tura River, where at Tiumen they embarked once more upon steamers for Tomsk. The Government long ago determined that a canal connecting the Obi and the Yenisei was indispensable to the development of Siberia, so an appropriation of 3,000,000 rubles was made and the work undertaken; upon its completion it was possible to travel by boat over 4,000 miles from a point in European Russia, near the Urals, to Kiakhta, on the border line of China. The vast low-lands of Siberia, constituting one-third the area of Asia, readily adapt themselves to the construction of waterways in almost any direction. Immense forests, greater in extent than any others in the world, supply inexhaustible quantities of



A STEAMBOAT BUILT IN SIBERIA FOR USE ON THE TRANS-SIBERIAN WATERWAY SYSTEM.

timber for locks. Great rivers flowing gently through the slightly sloping country are ready to float millions of valuable rafts to the ocean. Already English trading vessels steam from London to Yenisei, in the very heart of Siberia. With the completion of the Trans-Siberian Railway across Northern Asia, tapping each of its great waterways near the head of navigation, marvellous development has taken place in that vast but no longer unknown land. Where a few years ago the sound of a steamboat whistle was unheard, scores of vessels now ply the rivers of Siberia. At Tiumen are built steamboats that would do credit to any streams; from this point a regular line is maintained to Semipalatinsk, in Central Asia, near the Chinese border, a trip up the Irtysh of nearly 2,000 miles. Another line is



A TOW ON THE OKA RIVER.



LOCK ON THE OBI-YENISEI CANAL, SIBERIA.

maintained between Tiumen and Tomsk, while barges arrive regularly from Krasnoiarsk, Yenisei, Irkutsk, and the Baikal district, all laden with produce and bound for the Urals, where the railway receives their freight. When the Trans-Ural canal is completed thousands of tons of grain, now left rotting at the Siberian railway stations for lack of adequate transportation facilities, will find their way into Europe via a cheap and continuous water highway. The splendid coal, iron, and gold mines abounding in Central Siberia will be developed to their utmost, and the waterways of Asia will become as important as those of Europe. That Russia realizes the value of her Asiatic rivers is evidenced by the fact that all tariff is removed from goods entering Siberia by water, and the trade America has built up with Amur River ports, Russia hopes to see extended to her rivers emptying into the Arctic Ocean.

The rapids between Irkutsk and Lake Baikal are being improved so that steamers may ply between the lake and western Siberian rivers, and it is needless to state that if such a thing is possible the waters of the Khila River, emptying into Lake Baikal, and the Shilka, flowing into the Amur, will be connected by a system of canals. Their headwaters are within a few miles of each other, in the valleys of the Yablonoi Mountains. Lake Baikal, 400 miles long and 60 wide, rests between a range of mountains, its surface being 1,230 feet above sea level, but the depth of the lake is nearly 6,000 feet; the Selenga, emptying into its southern side, is navigable for many miles through the valleys; of this river the Khila is a branch. At Chita, 300 miles from Lake Baikal, the Shilka River becomes navigable by steamboats of a light draft, to the Pacific, more than 2,000 miles distant. However, the Government steamers seldom proceed further up stream than Stretinsk, where the Trans-Siberian Railroad now ends; from this point to Khabarovka, where the railroad running north from Vladivostok terminates, hundreds of steamboats and steel barges run on regular schedule. At Khabarovka the Usuri River flows into the Amur, and steamboats ply up this stream to Chanka Lake, 100 miles from the navigable waters about Vladivostok; in fact, the upper waters of the Usuri almost reach the city. That a connection between the arm of the sea at Vladivostok and the Usuri would be worth many millions to the Russian Government is demonstrated by the fact that the mouth of the Amur is now seldom used. Ships unload at Vladivostok instead.

In conclusion a few statistics in regard to Russian waterways may not be out of place. Along the 60,000 miles of navigable waterways

in European Russia there are more than 1,000 ship-yards, which turn out annually 6,000 barges and 150 steamboats. In all there are 3,000 steamboats and over 20,000 barges plying these waters, employing fully 150,000 men. The total tonnage of Russian river craft has risen within the last fifteen years from 6,000,000 tons to about 10,000,000. Fully one-half the number of steamers and one-third of the barges belong to the Volga system. About 25,000,000,000 tons kilometer are moved during the six months of navigation, the freight per ton being one-fourth as much as by rail, so that during the season of navigation the railroads are compelled to lower their rates, notwithstanding which fact the waterways transport during the half-year almost as many tons of material as do the railways during the entire twelve months.

In Asiatic Russia there are 65,000 miles of navigable waterways, over 100 steamboats ply the Obi, 25 the Lena, and perhaps 200 the Amur and Sungari, while in Central Asia six or eight steamers move the products of the Amu Daria.

In the newly acquired province of Manchuria Russia's waterway luck does not desert her; it is possible to float every bit of material needed for the Manchurian railway up the Amur and Sungari rivers to a number of points of intersection of the Chinese Eastern Railway. At one time the Chinese Government contemplated the construction of a canal across Manchuria; should Russia carry out this design the waters of eastern Siberia and the wonderful canal system of China would be united.

In every direction Russia is still extending her frontiers by means of waterways or the iron rail, but it remains for the future to decide whether or not the stupendous engineering projects of Prince Hilkoﬀ and his advisers can be carried to completion.

INDUSTRIAL ASCENDANCY OF THE ANGLO-AMERICAN PEOPLES.

By Casper L. Redfield.

CONTEST is an instinct inherent in all living things. Plants and animals struggle with each other for existence, and the struggle determines which shall live and which shall die. With man within historical times this struggle has taken the form of war for robbery and for the political power of kings. With the advance of civilization and the accumulation of property, war has become so distinct a disadvantage that, at the present time, preparations for war are taken principally for the purpose of averting war. Though war is becoming day by day less likely, the instinct of contest remains and contest in the future will continue to exist between races as it has existed in the past between tribes and nations. Looking into the future by the light of the nineteenth century, it may be said that the coming struggle will not be one for political power, but a struggle for industrial and commercial supremacy. Industry and commerce, having become the source of all power among civilized people, now demand that form of security for life and property which can be had only through strong and stable governments. The expansion of strong and civilized governments over those less strong and less civilized is one, and practically the only present, mode of obtaining security for life and property. Even in those forms of expansion that savor of political aggression, it can be seen that the motive is not a conquest for rule, but a conquest for stable government and industrial prosperity alike for the conquering and the conquered. Among civilized nations, this is as true of the absolute monarchy as of the republic. At the present time no nation seeks control in China for any purpose except the advantages that its citizens might derive in the way of trade and commerce. Could all of the financial advantages to be obtained by opening up China for the introduction of modern improvements be settled in favor of one of the European

It has been the steady preaching of this Magazine that, as engineering practice is the concrete expression of the material life of a nation, its elements will be found in the most deeply rooted institutions—racial, national, political, social. Mr. Redfield's analytical examination of the prospective trend of industrial power is strictly in accord with this conception. He goes direct to the primal elements of racial strength. An Anglo-American audience can hardly fail to be gratified at his conclusions.—THE EDITORS.

nations, that nation would be only too glad to surrender the political power to anyone who wanted it. It is known, however, that political control in the hands of one nation would permit that nation to favor its citizens at the expense of those of other nations, hence it is evident that the political jealousies of Europe may be reduced to the fears of each nation that its rivals will gain control of the markets that it itself is seeking. We thus see that the only animus actuating the powers in China is an effort of each to secure for its citizens the profit naturally arising from exploiting the resources of the empire. To those who may think that running governments on sordid commercial bases is degrading, the reply is that the old idea that governments exist for the glory and power of their rulers is a thing of the past, and that in the light of modern civilization the only object of a government at all is to secure to citizens the right to accumulate property and enjoy the benefits of it.

In a struggle for commercial advantage and the wealth that goes with the control of markets, success is the goal for which all strive, be the contestants individuals, nations, or races. Success of any kind is the result of work, and to attain success there must be the men to work, the tools with which to work, and the materials upon which the work is to be performed. Given the men, the tools, and the materials, the measure of success will depend upon the quality of these elements, and also upon geographical position and political influence. It is the purpose of this article to take up these elements in detail, and, by examining them, to arrive at some reasonable estimate of the relative advantages of different peoples in the coming struggle for commercial supremacy.

Omitting the United States from the consideration, the most remarkable thing in modern history is the expansion and rise in power of the British Empire. As the area of the British Isles is almost insignificant, and as their population is less than that of several other countries, it is evident that their overwhelming wealth and power depend upon the expansion of the empire and the quality of the men who were able to expand it. So colossal is this world-wide empire, owned by the British people and controlled from London, that it has been likened to a pyramid standing on its apex and liable at any moment to topple over. As we shall presently see, it is a pyramid resting firmly on its base—a base composed of superior men, of superior intelligence and superior education.

Man is an animal, and Darwin has shown that not only is he closely akin to other animals, but that the laws which control the

development of the lower animals also control the development of man. He has also shown that crossed breeds of animals are larger and stronger than either parent. Thus, while the crossing of one breed of sheep with another may deteriorate the particular product for which sheep are ordinarily raised, the animals themselves will be larger, stronger, and healthier than either parent. Modern science has shown that with man a sound mind goes with a sound body, and that the larger and stronger the physical body the better are the chances for a large and powerful brain. And finally, common observation and experience teach us that the strong body and the powerful brain open up the wilderness, make our inventions, build our railroads and steamships, and control our manufactories and commerce.

When we examine into the origin of the English people we find the ancient Britons fighting and mingling with the Romans, and subsequently with the Picts, Scots, Danes, Saxons, and Normans. For more than a thousand years these various breeds of men have crossed and recrossed until they have been molded into that homogeneous mass that we know as Englishmen. From what has been said before we can see why the Englishmen are inherently of a sturdy stock, and why they have brains competent to grasp and manage the affairs of a world-wide empire.

Turning to the United States, we find the foundations of a new nation laid by the sturdiest and most enterprising of these same Englishmen. They landed on the then distant shore, conquered the wilderness, organized a new government closely akin to the old, and invited the people of all the world to join them. These strangers came and are still coming. Here they meet and here the same commingling that went on in England is going on, more rapidly and on a larger scale. The Slavs, the Germans, and the Latins mingle together and in a few years become neo-Anglo-Saxons, or what may be more properly termed Anglo-Americans. The evolution going on in the United States is also going on in Canada, in South Africa, in Australia, in New Zealand, and in other smaller places scattered around the world. There is thus being formed, on a gigantic scale, a new race of men, built on the strongest lines on which it is possible to construct human beings. The different sections of this new race have a common language and literature, the same laws and customs, and the trend of industrial civilization causes them to have identical political interests.

It is an established induction of science that plants and animals reach their greatest perfection near their northern limit. Applied to man we see the most powerful and dominant of the old races located

in the temperate zone. Going northward into the frigid zone or southward into the torrid zone we find men less sturdy and less intelligent. This potential difference between men in the temperate zone and those in the tropics is well illustrated by Mr. W. Alleyne Ireland, who has given many years to the study of British colonies. He says that "taking the British Empire as a whole, it is found that every man, woman, and child in the non-tropical portions sends to England each year \$23.88 worth of produced material. Every man, woman, and child in the tropical portions sends to England each year 66 cents worth of produced material." This is a ratio of more than 36 to 1.

If we take a map of the world, or better yet, a globe, and trace the isothermal lines, we find the largest expanse of fine territory in the temperate climate in North America, and consisting of the United States and the southern half of Canada. The second in size lies in China; the third in central Europe; the fourth in Australia; the fifth in the southern extremity of South America; and the sixth in South Africa. This comprises practically all of the world that is suitable for the habitation of an active and energetic people. Of this territory more than one-half is in the undisputed possession of English-speaking Anglo-Americans. Of the other portions of the temperate zone, the only non-English speaking part yet open for considerable development is in South America, but the southern end of South America is the most isolated section of the world. In the frigid and semi-frigid portions Russia holds the largest section, while England holds the second in size. Within the tropics, England controls in India and Egypt the richest and most populous portions. It will thus be seen that, go where we will over the face of the earth, the English-speaking people have, in geographical position, an incomparable advantage over any other people.

If we look once more at the map and study it from a geological standpoint, we find that the greatest agricultural and mineral resources also lie within the sphere of Anglo-American influence. These are the materials upon which work is to be performed, and here again we find the advantages lying with the same people who had the congenital and geographical advantages.

Modern civilization rests upon modern engineering, and modern engineering depends upon modern education. In the past, education was supposed to be limited to the learned professions, by which were meant law, divinity, and medicine. To-day education occupies a wider field, and engineering is perhaps the most learned of all professions. While education has its foundation laid in schools and col-

leges, a comprehensive education consists of a broad knowledge of human affairs and events. This broad and most useful knowledge is gained by experience and from the current technical publications. It may thus happen that the best and most useful education may be possessed by men who never saw a college and very little of an ordinary school. That the English-speaking people have the best opportunities for acquiring the useful forms of education is shown by their technical publications, which exceed in number and circulation those of all other peoples put together. If technical publications were not used they would not be printed, and if they are used they educate. Experience is gained by contact with the world, and Anglo-Americans are noted for the extent of their travels and the amount of their communications with distant points. They make more use of railroads, steamships, and telegraphs than any other people. Another illustration of the comprehensive knowledge of English-speaking people is found in the language itself. The number of words indicates the number of ideas, and the number of words in the English language is three or four times that of any other language.

Education is one of the tools with which man works, and is that particular form of tool which enables him to handle other tools to best advantage. The other forms of tools are capital, lines for transportation and communication, commercial and manufacturing establishments, and the almost infinite forms of machinery in the invention, making, and using of which the Americans are the leaders. Of these various forms of tools not only are the Anglo-Americans as a class better supplied than is any other class, but they have more skill and experience in using them.

We thus see that there is a race of people of congenital superiority, the parts of which are linked together by ties of blood, of language, and of customs; that they are numerous and growing and are located in positions of geographical advantage; that the natural resources given into their possession are greater than those given to any other race; and that the tools and appliances which they have are better and more numerous than can be found anywhere else. If, with all these advantages, these people cannot win pre-eminent success, it will be because they have turned their backs upon progress to woo the goddess of degeneracy.

As to which branch of this race of people is likely to take the lead it is not the province of this article to deal, but it may be of interest to look at the immediate prospects before the people of the United States. Twenty years ago the country was just entering on an era of

prosperity after a serious and prolonged panic. To-day it is doing the same. With the men, tools, and materials at hand twenty years ago America built thousands of miles of railroads, founded and expanded cities, opened mines, erected manufactories, and put to use practically all the vacant land to be had. To-day she has fifty per cent. more men to do work; these men, especially in the engineering class, are better educated and trained and consequently are able to accomplish much more per individual; the available money capital is more than doubled; and machinery is several fold as plentiful and efficient as it was then. What is America to do with this tremendous potential energy? She cannot use it for building railroads in the same proportion as in the past, because she must have some ground left for agricultural purposes. She cannot use it in expanding her cities, because she could not fill them if she did. Doubtless some of this surplus energy will be used in added luxuries and in higher forms of education, but even then there will be a very large amount left over that cannot be employed advantageously within the United States. Fortunately there are in Spanish America, in the Philippines, and in China, fields for more improvements than can be furnished by the world in several decades. The greatest of these is in China, and the care of the United States there should be that no political settlement be made that will shut them out of a free and equal opportunity in that vast empire. If they should be shut out by discriminating spheres of influence, then a certain portion of American wealth-producing energy will go to waste, or else the United States will have to work at a disadvantage. In the Chinese field for development, the possession of the Philippine Islands gives the United States a distinct geographical advantage, and as they cannot benefit themselves without benefiting the people of those islands, it follows that territorial expansion not only means industrial expansion, but it means the bringing within the pale of civilization those who have been within the pale of barbarism.

ORGANIZATION OF THE FACTORY SALES DEPARTMENT.

By O. D. Hogue.



WELL equipped, modern shops, ample capital, able superintendence, competent operatives, and a product of assumed or proven commercial possibilities—all these being given, there yet remains to organize an efficient system of sales, advertising, shipping, and accounting. The matters of advertising, shipping, and accounting are mentioned in connection with the sales department to emphasize the advantage of having them under the direct control of this department in all matters wherein the service rendered the customer or consignee is concerned.

The spur of self-interest is then sufficient to insure that the customers' preferences and directions as regards packing, shipping, and billing will be fully ascertained and intelligently acted upon. Or, if it is not possible to conform to his recommendations, the necessary letter of explanation is more likely to come fully and promptly from the department most keenly interested in retaining the customers' continued trade and preference, rather than from those departments more removed from actual contact with the customer and less appreciative of the vital importance of neglecting nothing whatever that will tend to retain customers and trade. Of the direct accountability of the advertising department to the head of the sales department there can be no question. The necessity for close and timely co-operation is immediately apparent as soon as the wheels of business are set in motion, and they do not need to be further mentioned herein as separate departments.

The province of the mechanical engineer, as engineer, of course stops at the doors of the sales department. When he has completed the best possible construction at the lowest possible cost, he may well feel that his share in successful conduct of the works is completed. But the province of the industrial engineer extends over the commercial side of the enterprise also—from buying market to selling market—and he must be concerned with the machinery of trade and distribution as well as the machinery of production. It is with this conception of the position in which very many engineers are placed that the Magazine presents the accompanying brief practical review of the commercial aspects of mechanical manufacturing.—THE EDITORS.

In the case of business firms with closely allied connections, which can be depended upon to either buy or place the factory output, the question of sales is merely a matter of book-keeping; but in the vast majority of business dealings only the personal quality of attention and service distinguishes a concern from its competitors in both material and prices (understood, but never admitted), and the question of securing and retaining a normal share of current and profitable business is a vital one, and is generally given the attention that it merits.

These conditions indicate that the head of the sales department should be fairly competent to meet the requirements of the situation, as in no other position is any incompetency so noticeable and attended with such loss of old customers and failure to secure new business. Many examples illustrate the success of energetic, capable sellers in offsetting inefficiency of shop management and practice, until these shortcomings are slowly corrected in the growth and enlargement of the business fostered by the exercise of good judgment and efficiency in advertising and selling.

In starting a new business or reviving an established one, the necessity for getting promptly in touch with the greatest number of possible buyers is at once evident. As aids in this matter, there are the trade paper and the circular letter and a multitude of schemes of more or less merit, generally less as an average. The better class trade journal can be safely considered the back-bone of all inquiry-bringing schemes and efforts. The special circular letter, judiciously used, can be made to produce a very satisfactory number of inquiries, although, as a general rule, inquiries so stimulated do not yield as well in actual orders as the inquiries due to the regularly appearing, well-displayed advertisement. But the special circular letter in connection with matters of special interest, mailing new catalogues, new discounts, etc., is recommended, and will be found of much benefit in establishing regular correspondence with possible buyers. The combination of strong advertisements in the better class trade papers, with an occasional type-written signed circular letter, constitutes a force for publicity that will successfully introduce any commodity with merit, for which a rational use can be found by the trade in which the advertising medium circulates.

In the choice of advertising mediums there is much to be considered—circulation, standing, and appearance. Circulation is important, but *quality* of circulation is all-important. Better a moderate number of buying readers who value the publication sufficiently to pay

for it, than a multitude of mere names on a mailing list. A safe rule to follow in placing initial advertisements is to take moderate spaces in the best edited and most interesting of the trade journals circulating in the trade to be reached, and later modify the list as the resulting inquiries indicate and recommend. Again, it is absolutely necessary that the space purchased in the journals selected should be used to display matter that is attractive, pointed in phrasing, and calculated to make a favorable and lasting impression. Such an advertisement is possible, and no one now disputes that the advertising pages are examined as closely as any other.

A good advertisement can be prepared by anyone with the time and a thorough understanding of the matter to be made public. A clean, complete, direct statement, displayed in type of a size to be easily read, and enlivened with a good cut or white-on-black effect, is better than any arrangement savoring of the startling or the humorous. Very striking advertisements are possible by the use of unusual arrangement and design, but so many futile efforts are made in this direction that it is best to leave such attempts to the professional experts, subject, however, to the closest scrutiny by the sales manager before insertion in valuable space.

If the proper combination of time, talent and understanding is not available, money can be very well invested by placing the entire matter of preparing the advertisements in the hands of professional advertisement writers, of whom there are now several largely in evidence, whose work, moreover, as might be expected from those who intelligently cultivate a specialty, is of a superior order.

The appearance of the initial advertisement, if only passably good, is almost invariably followed by a most gratifying number of inquiries for catalogues and prices, followed later by an apparent industrial depression when the daily record of inquiries received is compared with earlier records. There is no occasion for alarm, however, and upon closer investigation the later inquiries will be found to grow more definite in their promise of business. If advertisements are keyed (and new advertisements should be keyed), a fairly accurate estimate of the business-bringing power of the different journals can be made and the list possibly rearranged with benefit when contracts are renewed. In this a distinction should be made between "inquiry producers" and "business producers." Herein the quality of the circulation is apparent, and an apparent lack of inquiries from a given source is often amply amended by the volume of business to be credited to it, owing to the publication being in the business-producing instead

of the inquiry-producing class. It is far from safe, however, to slight a seemingly idle inquiry, as close attention paid will develop many cases of bread cast upon the waters to return after many days. Further, it must be remembered that too minute attention to key indications may lead to serious error. A customer's inquiry cannot in every case be correctly traced to a particular publication. It may be taken for granted that constant appearance in a journal of assured value to, and large circulation among, a buying constituency, is certain to familiarize buyers with the name and merits of the article so advertised and to have a favorable effect on the general volume of business.

A complete record of all inquiries received and the total of the quotations made and business entered, when compared with the total cost of the sales department, permits of some interesting and at times startling comparisons. All of the comparisons will emphasize the urgent necessity for exhausting all order-bringing possibilities and giving to every detail pertaining to the securing of orders the closest continuous attention.

The cost per inquiry, when determined, will demonstrate that the additional expense of following up every definite inquiry until the order is secured, lost to the competitor, or the contemplated purchase abandoned by the prospective customer, is a good business proposition, and at no time a case of throwing good money after bad. All inquiries and communications should be promptly acknowledged as a matter of business form and courtesy. If further time is needed to reply fully to the writer, he should be so advised and definitely told when to expect a further and more complete reply. This is due to the party who offers a definite opportunity to secure business; he will appreciate it, and a good impression has been made even before the quotation reaches him.

In the United States, brief, pointed, and definite letters are preferred by the business interests. Such a letter need not be impertinent or unduly blunt. Outside of the United States a more elaborate and graceful form of correspondence obtains favor, but with a large business such forms add greatly to the stationery and labor account. The matter can be well decided by practice and individual tastes.

After the customer has been given quotations, a reply is due when he has been allowed two or three days in which to acknowledge and consider the offer made to him. The favorable reply will be promptly forthcoming in many cases. Others will need to be stimulated by what are known as "touch-up" letters. Such letters cannot be too ably dictated or too carefully considered. Their proper phrasing is an

art, largely a matter of particular talent in that direction, and of long practice. All inquiries not referred to travelers for full attention, should be completely threshed out by mail before recording for the annual catalogues and printed matter, and filed away permanently. A variety of office appliances are suitable for handling inquiries, the selection made depending on the volume of letters handled, bearing always in mind that the simplest appliance is the best.

In working over inquiries, the state of the deal governs the character and number of touch-up letters to be sent to obstinate cases. It is eminently right in these particular cases to bear in mind that having given an inquirer the attention he has requested, a definite reply is due in proper time, and that the later letters requesting it can have a moderate amount of that dignity due a position well-taken, entirely without being impertinent or jeopardizing future business possibilities. The cases referred to are extreme exceptions. It is rare that any reputable business man fails to accord others that information that he would want were the positions reversed.

Throughout all correspondence and negotiations, it pays well to consider the customer as the very good friend of the firm with whom he trades. A strong feeling of mutual respect will grow out of a relation so handled, which will make it and subsequent dealings a pleasure as well as mutually satisfactory and profitable. This friendly feeling for the customer should permeate the entire organization, extending to every employee having to do with the execution of his orders, and all should unite in giving the best and most complete service to the customer who is helping to support them with his trade. It pays to do this, and it is right, and in connection with competitive prices, is the open secret of trade extension and consequent prosperity.

ELECTRIC POWER MACHINERY IN IRON AND STEEL WORKS.

By Sydney F. Walker.



IRON is found in nearly every part of the world, in combination with other substances, and the process of preparing it for the market as iron, or in the form of its alloys, cast iron and steel, consists first in taking away the impurities with which it is combined when found in nature, and next in rolling or drawing it down to the form in which it can conveniently be made use of, such as bars, rails, sheets, and rods.

As in the matter of the working of collieries, electricity comes in at every step in the process of iron or steel making to perform some of the work, and though it has not gained such a complete ascendancy as in the case of coal mining, it is making rapid progress, has attacked problems that would not have been attacked in coal mining under the conditions, and even threatens to revolutionise the whole method of the manufacture of iron.

When the ore is shipped into the steamer that is to transport it to the furnaces it is, in many instances, now handled by means of an electric crane, and when it is unshipped it is often taken out of the ship's hold on to the wharf in the same manner. In America, also, the iron ore is often transported from the ship to the truck, and from an ore heap to a charging truck, by means of a rope haulage worked by means of an electric motor.

Arrived at the neighbourhood of the blast furnace, it is, at some ironworks, transported to the top of the furnace by means of a lift worked by one or two electric motors. The electric motors in this case take the place of the steam or hydraulic engine that formerly would have done the work, being geared to the last of the hoisting train in the usual way, but with special arrangements for control and for braking. In the case of the crane there are two electric motors, one of 50 horse power to work the hoisting tackle, and another of 10

Iron and coal are the great fundamental materials of all manufacture. Any economy in their production is directly transmitted down the whole line of constructive and creative enterprise. It is of signal interest, therefore, to follow Mr. Walker's recent review of electric applications in the colliery with this discussion of the work of the newest form of power in the great allied industry—iron and steel making.—THE EDITORS.

horse power to work the turning tackle. In this case the pioneers of the crane movement did not make the mistake so often made in connection with new electrical appliances—they did not make the power too small for the work; consequently the cranes are a great success. It may be noted in connection with the electric cranes that are used for unloading ships that it has been found that the regular crane drivers, the men who had been used to drive the cranes by steam, made the best electric drivers.

Electricity has not entered into the Bessemer process, up to the present, except to take charge of the ingots after they have been run from the converter. In some works an electric crane takes them away to be stripped from their moulds, so that the latter can be used again with less delay than would be otherwise necessary. In the matter of taking up the pigs from the bed, the sow, as it is termed, electricity has not come in, though it might be used with advantage to lift them and bring them to the machine that is used to break them up ready for the open-hearth furnace. Electricity has come in indirectly, however, to assist the iron master and the iron founder in using up materials that would be otherwise wasted. In the Bessemer process there is a certain amount of waste in pouring the metal from the converter to the ingots. The slag, which remains in the converter after the charge has been poured out, contains substances that would be very deleterious to the steel if poured with it into the ingots; but it also contains a certain quantity of iron held mechanically by the slag. The slag is ground up in a mortar mill and passed through a magnetic separator, which delivers the iron by itself, ready to be used for working up again. Magnetic separators also play a very useful part in the iron-founders' and brass-founders' business, by separating the iron out from the brass and other materials which are often found in the lots of second-hand stuff the iron founder buys. They are also used to enable certain qualities of iron ore to be used that would otherwise not be available, and in the same manner, by separating the magnetic oxide of iron from the other substances with which it is mixed. So far has this been carried that it has been proposed and carried out in a small way to raise certain lower oxides of iron to the magnetic oxide, by the application of heat, and then to separate the magnetic oxide by the magnetic separator, only the magnetic oxide being attracted by electromagnets.

Magnetic separators are of very many patterns, and the problem is by no means the simple one that it seems to be. It is comparatively easy to extract large masses of iron from their surroundings, because

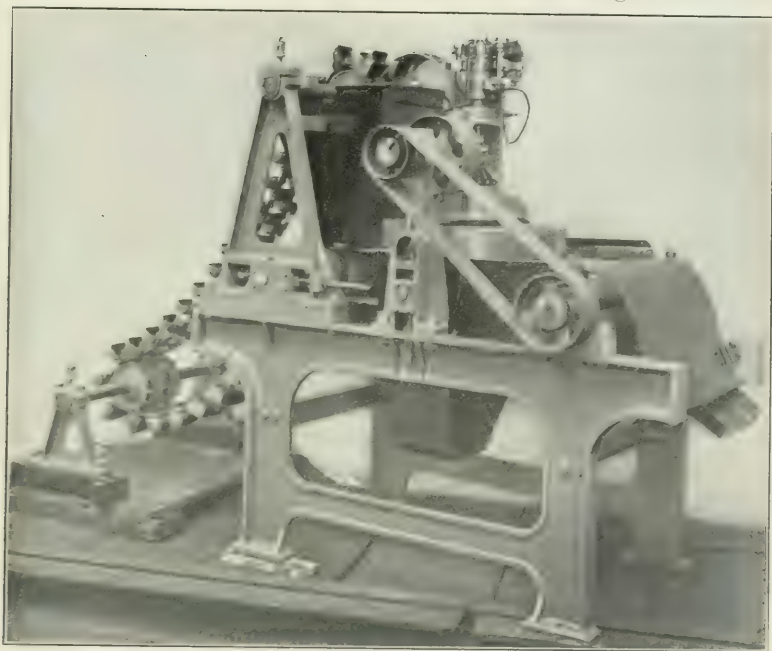
the iron itself takes part in the operation, becoming magnetised by induction; but when the iron to be separated, or the ore, is in a fine powder, the amount of attraction between the individual grains and the apparatus which is to hold them in the process of separation is very small indeed, and may easily be overcome by the cohesion of the other particles of the mass in which the grains are distributed; these grains may thus be carried away with the bulk of the material, instead of being delivered by themselves.

In a very beautiful form, and one that is most successful so far as my knowledge goes, the powdered substance in which the iron is embedded is led down a shoot over the surface of a revolving brass drum. On the inside of this drum electromagnets are placed, occupying a portion of the periphery, and the poles of these electromagnets are of opposite signs, round the drum. The electromagnets are very powerful, and are fed with current from the ordinary electric supply of the works, or where there is none, by a separate dynamo. As the powdered material passes down over the curved surface of the drum, the iron particles, or those of magnetic oxide, cling to the first magnet pole they reach; but on arriving at the next pole they turn over, attaching themselves to the magnet pole by the opposite end to that by which they were held to the first pole, and on arrival at the third pole the reversal is repeated, so that as the iron particles go round the drum they throw off any of the nonmagnetic material that may be clinging to them, and so the cleaning is very much more efficient. Though the electromagnets are necessarily made very powerful, in order to make up for the small mass of the iron grains, the whole power required is comparatively small, a nominal 15-horse-power engine being sufficient for the mortar mill which is used for grinding up the slag and for the dynamo furnishing the electric currents required to energise the electromagnets.

Another form of magnetic separator is in the form of a belt, which carries the material up to some electromagnets, where the iron is delivered to another belt, which again passes it to a separate heap.

For the open-hearth furnace a very beautiful apparatus has been worked out for the purpose of charging the iron into the furnace. Under the old plan the iron is fed into the furnace by hand, men standing at the open doors of the furnace and throwing through the furnace doors the pigs and other material of which each charge consists. In Messrs. Wellman-Seaver's plan a charging box is filled with the necessary quantity of material and brought into the neighbourhood of the furnace, a bogie truck bringing up a number of the

charging boxes which have been filled at another part of the works. On one end of each charging box is a socket, and into that socket fits a long bar, which projects from a platform slightly above the level of the furnace doors. The charging bar, as it is called, is hollow, and is locked, when in position in the socket of the charging box, by an inner bar, which is forced down into a place provided for it. Having grasped the charging box with its freight, the charging bar is raised up to the level of the furnace doors and forced through one of them.

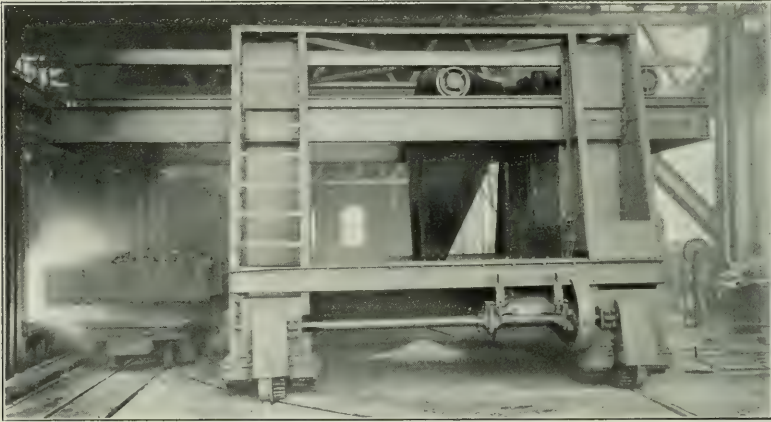


A MAGNETIC SEPARATOR FOR USE IN STEEL WORKS

By Messrs. Ernest Scott & Mountain.

When the charging box is in the right position, within the furnace, it is turned over by a revolution of the charging bar, its contents being emptied out into the furnace or distributed over the bottom of the furnace, as arranged by the man working the charging machine. When the box is empty, the charging bar is made to resume its normal position, and with it the charging box, which is then withdrawn from the furnace and deposited on its bogie truck ready to be hauled away for a fresh load. The whole apparatus is worked by electric motors, there being four in all, three of 25 horse power each for the lifting and traversing motions (the charging machine moves along the front of the furnace), and one of about 4 horse power for the twisting motion

of the charging bar when inverting the box. The maximum power consumed at any moment is given at 25 horse power, while the average power is stated not to exceed 10 horse power, though at the instant of raising the charging box off the bogie the maximum figures given are probably exceeded. All operations are controlled from a platform arranged for the purpose, placed in a position in which the operator



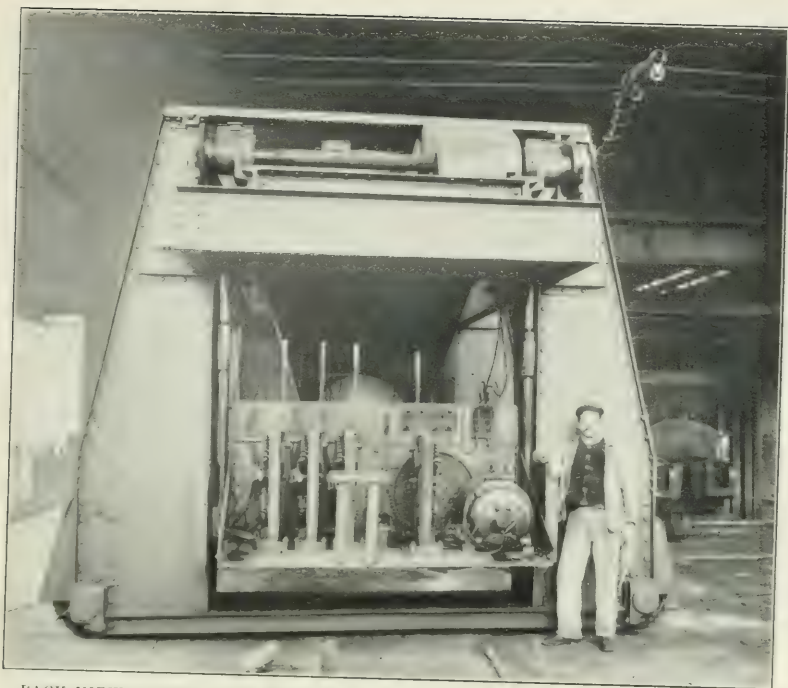
SIDE VIEW OF WELLMAN-SEAEVER ELECTRIC FURNACE-CHARGING APPARATUS.

By courtesy of Jeremiah Head & Sons.

can see right into the furnace, and he has his switches and controlling gear close to his hand.

It is interesting to note that the first attempt to construct a charging machine for the open-hearth furnace was by means of hydraulic power, but it was not successful.

After being properly worked, the Siemens-Martin product is run into a kettle, just as the iron from the blast furnace and as the Bessemer product is, and from that is run into ingot moulds, which in some cases are taken away by an electric locomotive to the stripping house; there the steel ingot is released from its mould and the latter hauled back to the melting house, the ingot being taken to another part of the works, by means of an electric crane, for further heating before being worked up. Neither the rail mill nor the plate mill has yet been worked by electric motors, though every accessory is so worked. Thus electric cranes are used wherever a crane can be useful, and in addition a special form of electromagnetic brake is employed to prevent the cranes from lowering when not required; further, the plates and other masses of iron are lifted by means of electric cranes having electromagnets for the attaching arrangements, in place of



BACK VIEW OF WELLMAN-SEAYER ELECTRIC CHARGING APPARATUS FOR OPEN-HEARTH FURNACES, SHOWING REGULATING GEAR AND LEVERS.

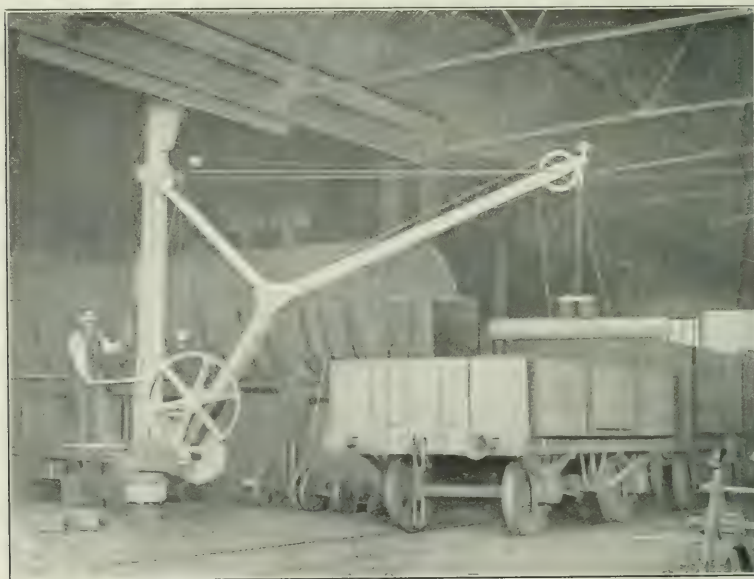
By courtesy of Messrs. Jeremiah Head & Sons.



YARD OF AN AMERICAN STEEL WORKS, SHOWING CHARGING TRUCKS FOR OPEN-HEARTH FURNACE BEING TAKEN UP AN INCLINE WORKED BY ELECTRIC POWER.

hooks or other arrangements. Iron and steel lose their susceptibility to magnetism at a certain temperature, approximately 500° centigrade, so that they cannot be handled till they have cooled to that extent, and even then the power required to lift a given mass is largely in excess of that required when the mass is cold; but the convenience is very great, while the excess current would only be in use for a short time.

Those who have been through an iron works when rails or plates were being rolled will have noticed that in front of the rail, as it issues from the rolls, like a huge red snake, are rollers for it to slide over to and fro, these rendering the work of the men who are attending the mills very much easier, or, in fact, rendering it practicable. These rolls, in modern iron works which are electrically equipped, are set in motion by electric motors. Also the saws which cut the rails and bars to the lengths required, the tools, which grind the ends of the rails true, the drilling machines for the fish-plate bolts, the gear for lifting the rollers for the mills, all are worked by electric motors.



JIB CRANE LIFTING IRON WITH ELECTRO-MAGNETS.
Sandycroft Foundry & Engine Works Co., Ltd., Chester.

For practical purposes it may be taken that whatever can be done about an iron or steel works with a motor or a number of motors whose individual ability does not exceed 50 horse power, is now so worked in the most modern of works, particularly in America, which



MOVABLE CRANE LIFTING AN IRON PLATE BY ELECTRO MAGNETS.

Sandycroft Foundry & Engine Works Co., Ltd., Chester.

has led the way in this, as in so many developments of electricity. Above motors of 50 horse power the matter appears to be looked at still with considerable doubt by iron and steel manufacturers, and for the perfectly logical reason that if the motor is put to a piece of work that it is unable to master it stops and burns up, or blows its fuses, or throws its cutout, a nuisance in either case.

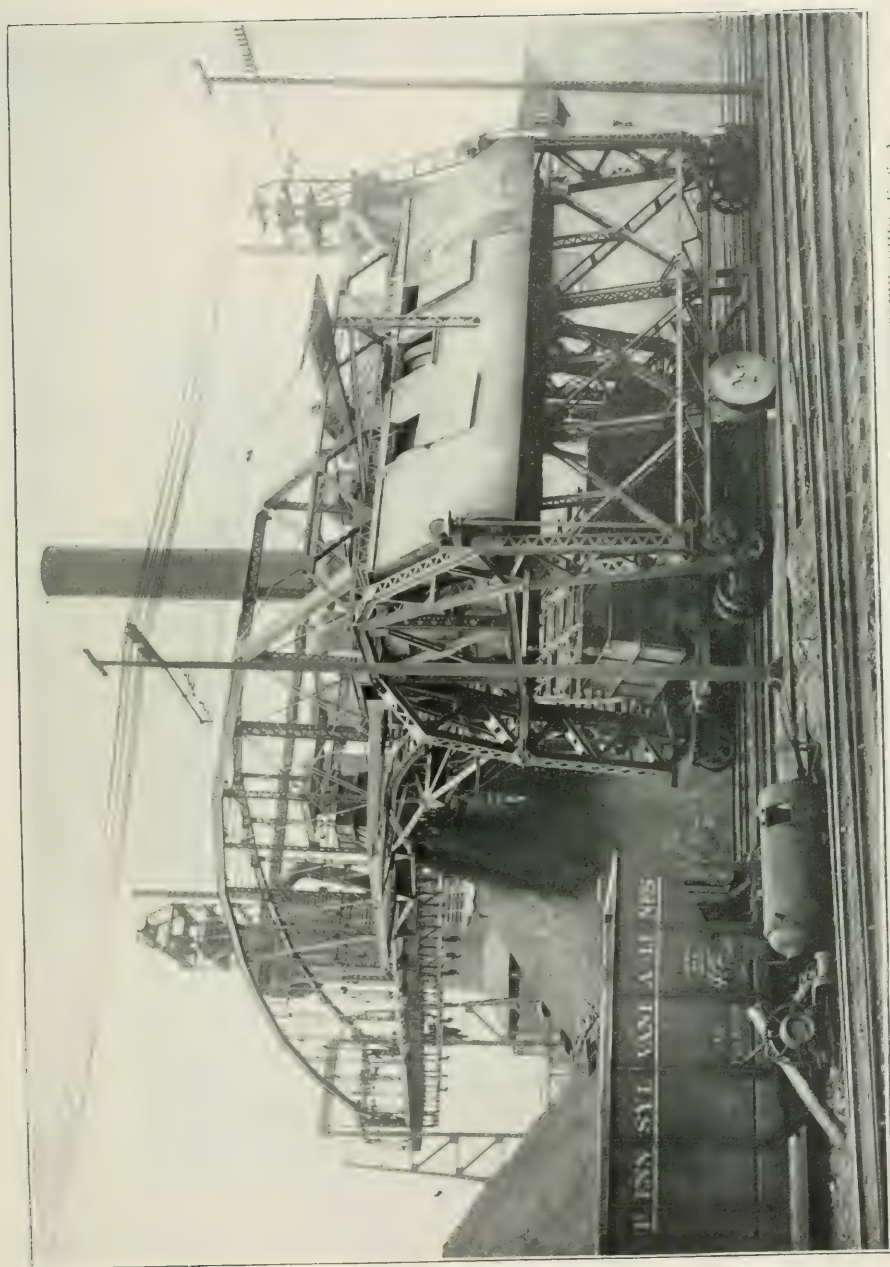
In my opinion there is really no ground for this apprehension, nor any reason, beyond manufacturing reasons, as applied to the motors themselves, why electric motors should not be employed with success in the rail and plate mills, and I have very little doubt that this will come to pass before very many years are over. The great objection is, of course, the old one—the terribly sudden strains that are brought to bear on the motor, whatever it may be that is in use, when the rail is first entered in the rolls: but this is a question that both English and



ELECTRICALLY OPERATED CHARGING CRANE, BETHLEHEM STEEL CO., SOUTH BETHLEHEM, PA., U. S. A.

Equipped by the Westinghouse Electric & Mfg. Co.

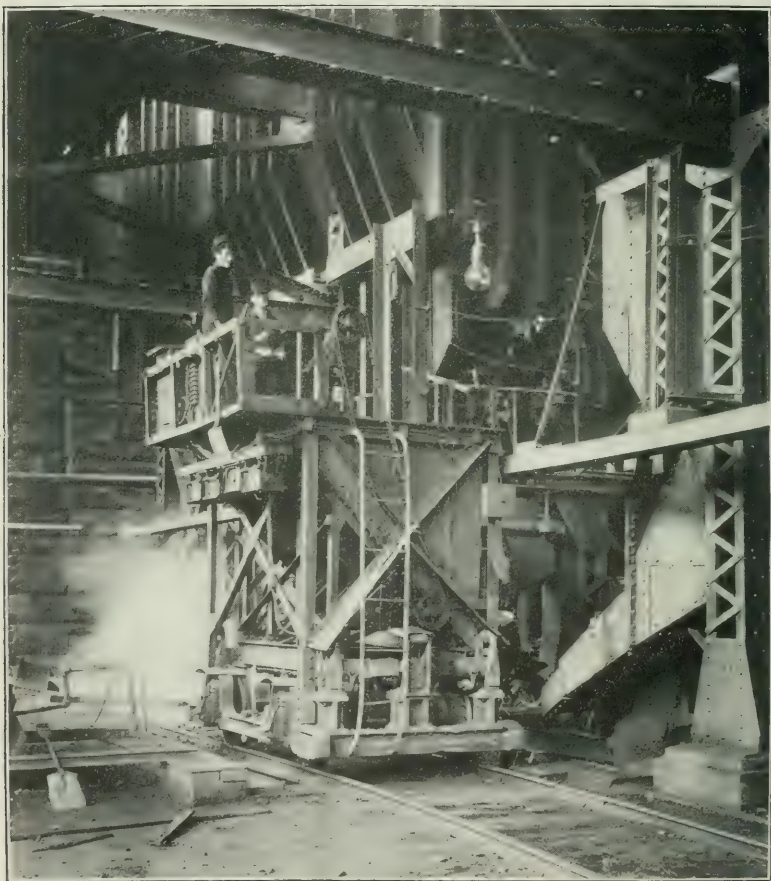
American engineers are fully qualified to deal with. The present engines must stand the strain, therefore the conditions should be known on the mechanical side of the problem, and the conditions on the electrical side are still easier to deal with, as electrical measurements are so much more easily made. The one thing to be remembered by whoever attacks the problem is that he must ascertain the *extreme* power that the motor may be called upon to exert, by actual



ELECTRICALLY OPERATED ORE BRIDGE, NATIONAL STEEL COMPANY'S WORKS, YOUNGSTOWN, OHIO, U. S. A.

A gantry crane of 250 feet span, weighing about 750,000 lbs., built by Webster, Camp & Lane Machine Co. and equipped with two General Electric 130 horse-power motors. There are two tracks—an upper one for cars used in stocking ore, a lower one for the trolley used in scooping; power for both purposes is transmitted by wire ropes. The car weighs 7,000 lbs., and load 34,000 lbs., the scoop bucket weighs 6,000 lbs. and ore 20,000 lbs. About 20 buckets per hour is the capacity. The best record is handling the contents of 134 railway cars in 12 hours.

measurement upon existing plant, and he will be wise if in the motor or motors that he puts to do the work he provides a very large margin over and above this. Then he will, in all human probability, be successful, and the work will be done more economically than at present, for the same reasons that electric motors are more economical in other places. Size should not frighten engineers, and the motors will use little more power for being above their requirements. In too many instances the power applied to perform a given work, when it is to be done by electric motors, has been that which it was calculated in the



ELECTRICALLY OPERATED BIN-FILLING CAR, NATIONAL STEEL COMPANY.

This car takes ore from the ore bridge shown on page 867, making a trip for each bucket scooped, running over the bins and depositing its load in the proper bin. It is operated by a General Electric motor of about 75 horse power, weighs 20,000 lbs., and can make a speed of 10 miles an hour.

drawing office *ought* to do it, without the usual check which a practical test gives and which can now so easily be applied by means of the motor itself. It cannot be too strongly insisted upon that there is no reason why an electric motor, any more than any other, should stop if it has or can obtain the power it requires to do the work in front of it:



ELECTRIC-DRIVEN SCALE CAR, NATIONAL STEEL COMPANY, YOUNGSTOWN, OHIO.

This car carries ore, mixed in the requisite proportions, from the bins to the skip bucket, which in turn delivers it to the furnace, being electrically operated and automatically controlled. The scale car weighs 18,000 lbs., takes a load of 16,000 lbs., and can attain a speed of 15 miles an hour when the distance is long enough to allow full acceleration. It is operated by a General Electric motor of about $27\frac{1}{2}$ horse power.

the only precaution necessary—the principal one, at any rate—is to see that there is plenty of power available in the source of current and that the motor is capable of absorbing and converting the extreme power it may be called upon to deliver. Sanguine estimates are always the forerunners of trouble, in whatever matter they are taken. An electric motor is as good-natured as most motors, but the user always suffers for over-working it, and the principal difference between it and steam or other engines in this respect is that the user generally suffers earlier with the electric motor than with the others, which is, in many cases, to his ultimate advantage.

The electromagnetic brake described is another pretty application

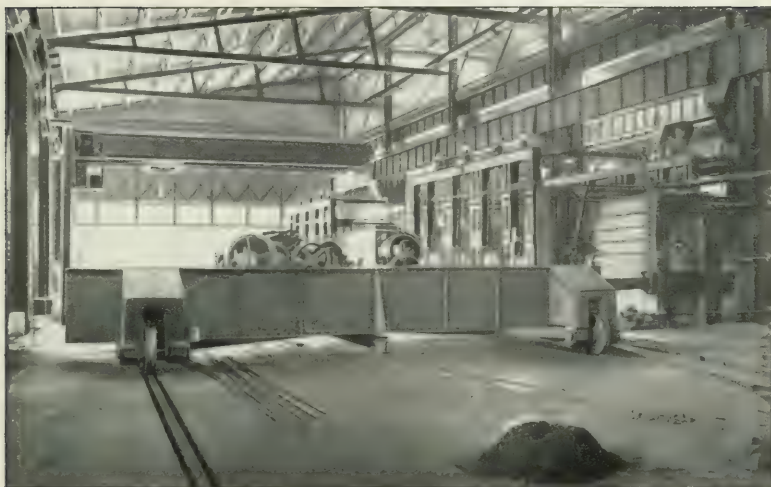
of the flexibility of electric apparatus. It consists of a number of discs strung on the armature shaft of the motor the brake is to control. Half of the discs are stationary, and the remainder revolve with the armature, the stationary discs being secured to an outer casting provided for the purpose. The casting also holds a very strong spiral spring which bears upon the discs, and locks them together so that the armature cannot revolve until they are released. In the casting is also fixed an electromagnet, which acts in opposition to the spring, by attracting the stationary discs and thereby releasing the discs which are connected to the armature and allowing them and the armature to revolve. When a current of certain strength passes through the coils of the electromagnet the discs are attracted and the armature released, and immediately the current falls below that strength the armature is locked. In the case of an accident involving the cessation of the current the motor is effectually braked.

The electric furnace, in which the arc formed between two carbons



ELECTRIC LOCOMOTIVE FOR HANDLING LADLE CARS, NATIONAL STEEL COMPANY'S PLANT, YOUNGSTOWN, OHIO

Used to shift ladles of hot metal in the mixer house, where the entire furnace output is taken. An average load is five ladles, each weighing 38,000 lbs. and carrying 40,000 lbs. of metal. The speed is three or four miles an hour, 500-volt motors being used to get the slow speed without gearing. Two motors are placed on each locomotive. The power varies from $23\frac{1}{2}$ horse power, light, to 103 horse power with 6,600-lbs. draw-bar pull. Equipped by the General Electric Company.



ELECTRICALLY OPERATED FURNACE CHARGER, CARNEGIE PLANT, HOMESTEAD WORKS.

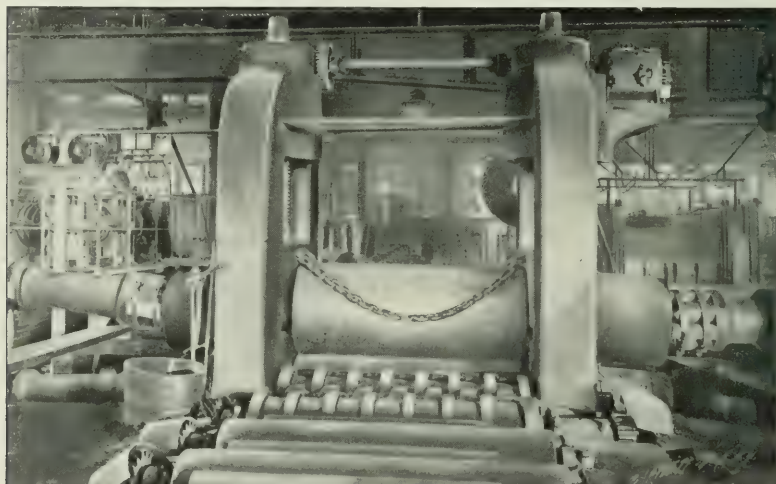
Westinghouse Electric & Mfg. Company's direct-current motors.

is utilised for melting metals and refractory substances, has not come into use for iron works up to the present. There is a possibility, however, of iron being made from the ore without smelting in any form, as it is now understood. Mr. Cowper-Coles, who has done so much with the electric furnace, has also been experimenting upon the process of building up iron from a solution of the ore in somewhat the same manner as he now builds up copper tubes, though not necessarily in the form of a tube, and as electrical energy can be obtained from any convenient source of power, this would mean the complete revolution of the methods of production of iron and steel.

Light is also required for the various operations that have been described, as many of them have to go on all through the twenty-four hours. The electric light is largely used, and has been ever since the advent of the Brush arc-light system. The beds on which the molten metal is run out from the blast furnace, the back of the blast furnaces, the tops of the furnaces, the yards of the iron works, the neighbourhood of the Bessemer and of the open-hearth furnaces, the engine houses—all require lighting at night.

For the yards, the furnace beds, and the neighbourhood of the Bessemer and open-hearth furnaces, and the rail mills, the arc light is usually employed, while for the engine houses and for the tops of the furnaces, where the spaces are confined, incandescent lamps are

used of sizes varying from 16 candle power to 500 candle power. At one time the arc lamps were displaced by the large incandescent lamps altogether, because the latter gave a light that could be depended upon, even if it was smaller for a given expenditure of energy, and cost less to maintain. Since then, however, the large incandescent lamp has not improved—if anything, it has gone back—while the arc lamp has very considerably improved, and in the enclosed lamp are combined most of the advantages of both forms; hence the enclosed arc lamp has taken the place which the large incandescent lamp had acquired at iron works, about the yards, etc. The matter of the cables about an iron works is a source of some anxiety to the electrical engineer, who is responsible for the successful working of the plant.

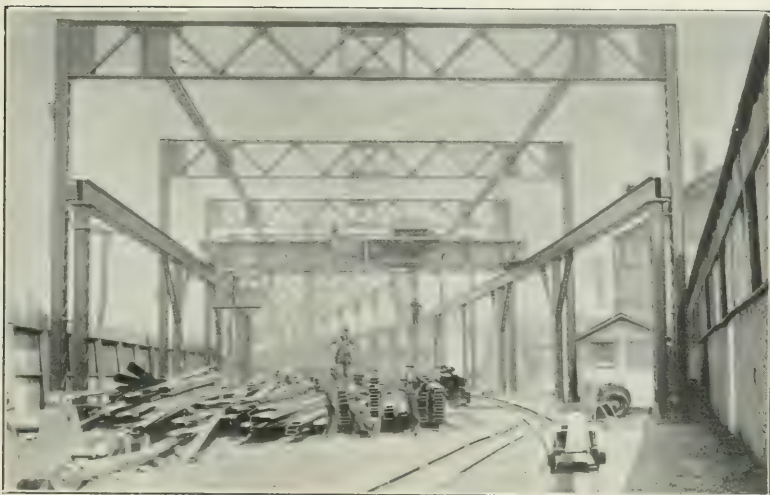


ELECTRIC MOTORS APPLIED TO RAISING AND LOWERING ROLLS, PARKGATE IRON & STEEL WORKS, LIVERPOOL.

Westinghouse direct-current "steel-mill" motor equipment.

There is always a considerable quantity of dust about an iron works, coming from the ore and the iron in its various operations, that settles upon the insulating envelope of the cables, and with the wet, the vibration that is always present in any works, and the assisting action of the electric pressure that exist in the cables, the insulating properties will gradually be destroyed. India-rubber has so far been used very largely for the insulation of cables about iron works, though vulcanised bittite has also been employed.

The great cause of failure in the matter of cables has been the exercise of too great economy—false economy—in the amount of india-rubber that has been put on the cables. In many instances, in



ELECTRIC APPLIANCES FOR HANDLING BEAMS FROM 33-INCH MILL, HOMESTEAD STEEL WORKS.

The peculiarity of this construction is the arrangement of the crane to travel on a curve, so as to utilise ground lying along the railway siding.



GENERAL VIEW OF ELECTRIC APPLIANCES FOR HANDLING BEAMS, HOMESTEAD STEEL WORKS OF THE CARNEGIE COMPANY, MUNHALL, PA., U. S. A.

Above are seen the travelling cranes; below, on the left, is the travelling table for carrying beams from the yard to the cutting-off saw.

the United Kingdom, at least, a wrapping of pure rubber has been thought to be sufficient, as the cable was in the open; but the action of rain, followed by heat, with the deposit of dust that has been mentioned, has been forgotten, and so leakage currents have been set up at each support of the cable, which have destroyed the insulation at those points, and the process of deterioration has gone on till there has been serious trouble from connections between the conductors and the iron work of the plant. The whole trouble, as usual, might be avoided by the provision of cables covered with a thick coating of vulcanised rubber, overlaid with some substance, such as yarn, that will protect it from the action of the wet and the friction of the metallic masses that it is practically impossible to keep it clear of; but the wrapping should also be of good thickness, and the cables should be overhauled periodically and any damaged places repaired.

The generating station for an iron works differs very little from that for a colliery, except that the former, at present, is usually larger.

The same question arises as to whether the lighting plant shall be separate from, or shall form a part of, the power plant. In answering the question a good deal depends upon the extent and the form of the lighting. Where the lighting has been done with arc lamps for a number of years before the advent of the power plant, if it is still usable and efficient, it is often the practice to allow it to remain, driven by its separate engine; but in most modern iron works the amount of lighting has far outgrown the old Brush plants, good servants as many of them have been, and the question is rather one as to how the arcs, when there are many, shall be fed with current. If the works are very extensive, it may be economical to adopt the old series system, especially where all of them will be in use all and every night. But in by far the greater number of cases, either the simple parallel system, in which each arc takes its current direct from the supply cables, just as incandescent lamps do, or the series parallel system, in which a group of lamps (two or four) take their current from the supply cables, will be more convenient and more economical. Where the simple series system is adopted, with a very large number of lamps—say sixty or more—in series, the machine to furnish the current for them must be a series arc-lighting machine, and must be driven by its own engine, or by a separate belt from a countershaft driven by the engine which is driving the other machine. With the simple parallel system, or the series parallel systems, the lights can be taken off the power supply cables if desired, but in my opinion it is better to have entirely separate plant for the two services, and for the same reasons that I gave



ELECTRIC CRANES HANDLING BEAMS AT THE PLANT OF THE EISEN UND STAHLWERK HOESCH, DORTMUND, GERMANY.

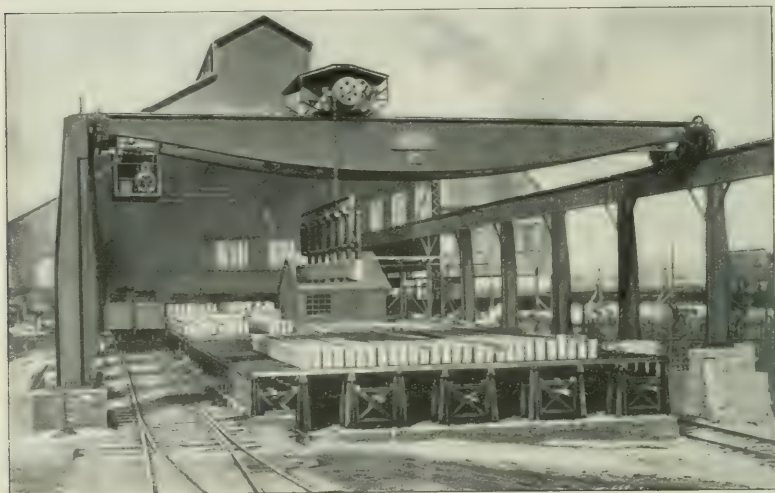
Effective travel of trolley 48.5 meters each way from center—97 meters altogether; capacity throughout the entire length, 5 metric tons. Speed of trolleys 250 meters per minute, of crane along track 90 meters per minute, of hoisting with full load 60 meters per minute. The legs of the crane are far enough apart to allow beams 15 meters long to be carried through without interference. All functions are operated by a single 500-volt direct-current motor. Brown Hoisting Machinery Co., Cleveland, O., U. S. A.

for the opinion in my article on electricity in collieries,* viz.: there may be considerable fluctuation in the pressure of supply of the power service, as machines are put on or taken off, which no governor will compensate for quickly enough to avoid unpleasant blinking in the lights. In addition, it is possible to economise considerably in the cables for a large power service by adopting pressures of supply that would be exceedingly inconvenient for the lighting service, as it would necessitate a very large employment of the series parallel system in the lamps, and the consequent turning in and out of lamps that it would not always be convenient to have worked in that way.

The only question remaining to be discussed is the form of the current. In all the iron works that established electrical plant for lighting and power in the United Kingdom up to a few months ago continuous currents were employed, and the motors were nearly always shunt-wound, the generating plant consisting of one or more four-pole or six-pole dynamos, driven by compound engines; the later plants, however, have some of them been laid down on the polyphase system, and there seems every prospect of that system being very largely adopted. It has the enormous advantage that the motors, which must necessarily be placed in all sorts of positions where they will be subject to rough usage and to conditions which will tend to make the commutators form flats and spark, have no commutators, and can be completely enclosed without the necessity of overhauling that is

* THE ENGINEERING MAGAZINE, Aug., Sept., 1900.

necessary with the enclosed continuous-current motor. It has now been proved, also, that the polyphase motor has all the self-regulating properties that the continuous-current motor has, and in a higher degree; its one failing, if it be a failing, being that it will not stand more than a certain percentage of overload. This really means only that a larger motor is to be fixed where it is likely that an overload will have to be met if a polyphase system be employed than if the continuous-current system be employed.



ELECTRIC TRAVELLING CRANE WITH LIFTING MAGNETS, OHIO STEEL COMPANY'S WORKS, YOUNGSTOWN, OHIO, U. S. A.

Operated by Westinghouse direct-current motors.

In my opinion this is a fault that might very well be encouraged. Too many plants are put down with apparatus very close, in their capacity for work, to the work they have to perform day by day, with the result that when extra work is met with, in the form of friction and the like, the apparatus becomes a source of trouble.

The polyphase system has also the disadvantage that three wires are necessary for distribution, but that is not serious with a careful engineer and careful hands under him.

AUXILIARY STEAM AND WATER APPLIANCES FOR WATER-TUBE BOILERS.

By B. H. Thwaite.

IT has been demonstrated that the evolution of the water-tube steam generator has now reached a stage that securely fixes its position as the agent *par excellence* for converting heat into motive power in steam engines, and especially for naval purposes. The undoubted imperfections associated with the pioneer forms of the water-tube steam generator, especially of the large-water-tube type, have provided weapons for its more or less prejudiced enemies, and only by the removal of the defective types will the power of the opponents be destroyed and general confidence be secured.

The existing stage, of securing confidence after the incidence of partial failures, is a critical one; but it is common to the history of all great innovations on established procedure. The supervision of the water-tube type of steam generator requires a higher intelligence to secure economy than is necessary for the shell type. It is well-known that all the instruments of applied science require, and in increasing measure as they approach perfection, a higher degree of intelligence in the character of the supervisor and his associated workmen. The era of change is naturally a trying one, but corresponding difficulties have over and over again been met and solved in the progress of mechanical development, and the invariable result has been improvement, both in the character of the work performed and the character of the personnel employed upon it. In the case of the water-tube boiler, moreover, much thought and ingenuity have been expended by designers in equipping their boilers with automatic feed-water regulators and efficient steam separators, which aid the men in charge as much as possible in securing steady and satisfactory work from the boilers without overtaxing strain in their management.

The supreme importance of dry steam is sufficiently recognised

It is not uncommon in mechanical development to find success or failure hinging upon an apparently very minor problem, rather than upon solution of what appears to be the main issue. The water-tube boiler instances this peculiarity, in the great importance which attaches to the devising of means merely for regulating the water supply and for taking away dry steam. The interest awakened by Mr. Thwaite's articles on the Water-Tube Boiler for Naval Service, published in this Magazine in November and December, 1900, assures the value of this study of effective means for meeting the supplementary requirements of the cooling type of marine steam generator. THE EDITOR.

and requires no further emphasis. In water-tube steam generators the rapid circulation of the water and its admixture with steam *en route*, often tend to the production of very undesirable priming effects. If the generator tubes are what is technically termed "drowned" (or

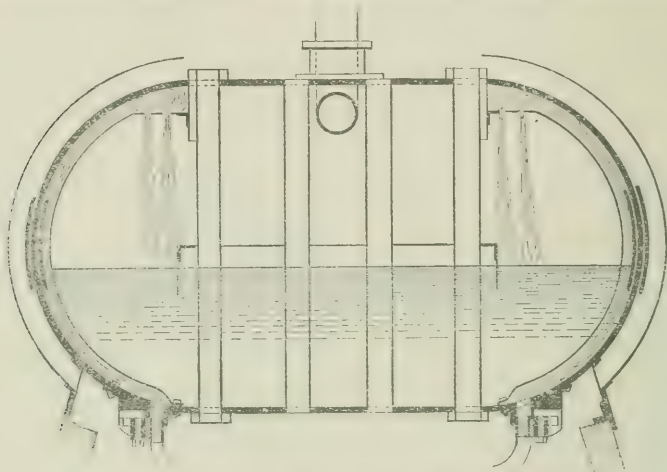


FIG. 1. ORIGINAL APPLICATION OF WIRE DRAWING PRINCIPLE.

contain water throughout their entire length) the violent expulsion of steam and water through their upper outlet ends will produce a disturbing effect on the water contents of the steam-and-water drum and there will be a decided tendency in the direction of priming and towards the production of wet steam. Thornycroft recognised this, and arranged his generator-tube upper terminals at a position above the water-level in such a way that the water part of the mixture ejected from the tubes into the drum rained down onto the water contents of the drum, and the ebullition is therefore not so liable to produce priming effects and it is comparatively easy to effect the separation of the steam from the water. The principle underlying

most of the arrangements adopted by most of the water-tube-generator makers for effecting the separation of the water from the steam may be termed one of aqueous coherance. The steam is projected against sheet-iron or zinc baffle plates, and the particles of water are held by the water already on the surface or flowing over it. Considerable ingenuity is displayed in the disposition and arrangement of the baffle plates, as

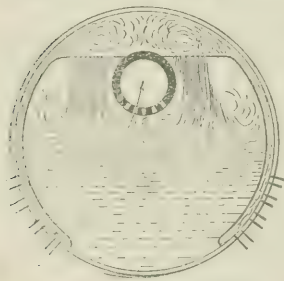


FIG. 2. WIRE DRAWING THROUGH APERTURES.

the figures to be described clearly shew. An alternative arrangement is the application of the wire-drawing principle, apertures of knife-edge dimensions or in circular form being provided, through which the steam and water are compelled to flow, the two being separated by a kind of filtration effect. Owing to the physical or density difference between the vapour and water, the former easily passes through the aperture while the water is left behind. The original application of this principle to water-tube practice is shewn in Figures 1 and 2; Figure 3 shews the application of the knife-edge wire-drawing system. A somewhat similar principle is adopted by Thornycroft in his suspended vertical grid device (see Figure 4). It will be seen that he suspends, in a position fronting the tube ends, a sheet-iron baffle plate hung from the crown of the drum, which may carry in suspension a series of grids through which the steam is compelled to pass, as shewn by the arrows, on its way to the steam pipe.

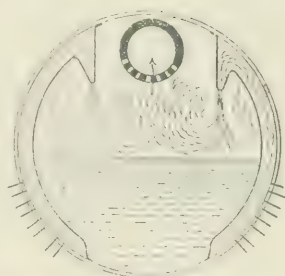


FIG. 3. WIRE DRAWING BY KNIFE-EDGE APERTURES.



FIG. 4. THORNYCROFT'S SUSPENDED GRID.

Another arrangement of Thornycroft's is shewn by Figure 5; the direction of the flow of steam is indicated by the arrows. A semi-circular baffle plate receives the steam and water ejected from the tubes, the lower edge of the baffle plate reaching to the normal level of the water in the drum; the edges of the baffle plate in contact with the water may be formed of zinc. Figure 6 shews the arrangement adopted by M. Niclausse; it consists of an ingenious disposition of baffle plates well-contrived to effect the separation of the water from the steam; the position of the feed water inlet and also that of the

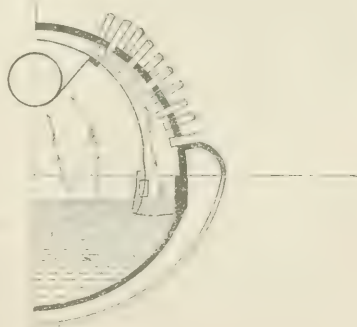


FIG. 5. THORNYCROFT BAFLE-PLATE SEPARATOR.

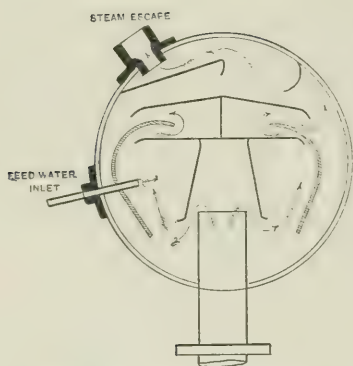


FIG. 6. NICKLAUSSE SEPARATING DEVICE.

length of the drum, or it may be a finely perforated plate. In both instances the water is retained on the underside of the plate, from which it eventually falls by gravity onto the surface of the water in the drum. This Figure 8 shews an arrangement of suspended zinc plates, having for its object the preservation of the baffle plate and the internal plate surface of the drum. It is arranged to be in contact with the surface of the drum near the water line. It is this part immediately above and below the water line that is most subject to corrosion.

Figure 9 shews such a striking innovation from the established practice that it must be described. It will be seen that the water rises into a central tube in the steam

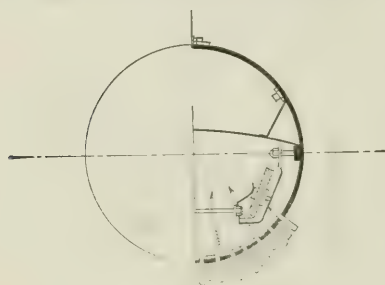


FIG. 8. ANOTHER BAFFLE-PLATE DEVICE.

space. This tube has on its underside a series of perforations through which the water, separated from the steam, can fall either onto the water level or onto an intervening trough, both arrangements permitting the easy escape of the bubbles of dry steam.

Another arrangement of the baffle plate is shewn in half-section by Figure 8. This plate extends across, and may also extend to, nearly the full

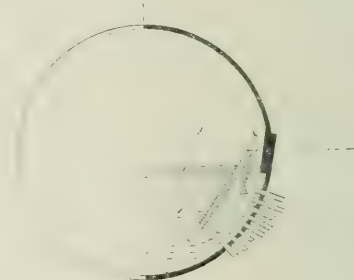


FIG. 7. DU TEMPLE'S ARRANGEMENT.

Besides the baffling arrangements described, an auxiliary apparatus is often located between the

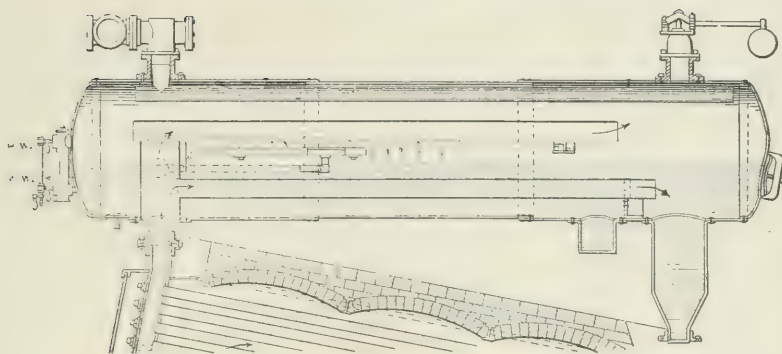


FIG. 9. SEPARATION BY MEANS OF PERFORATED TUBE IN STEAM SPACE.

steam generator and the steam engine, somewhere in the line of the steam pipe, which not only automatically separates the steam from the vapour, but ejects the resulting condensed water; Figure 10 shews clearly the working of this apparatus, the flow of steam being in the direction indicated by the arrows. In forcing its way through the grid (A) it is wire-drawn and the suspended water is separated on the under side of the grid, eventually falling to the bottom of the vessel, where it gradually accumulates until it attains such a depth as to lift the float B. The movement of

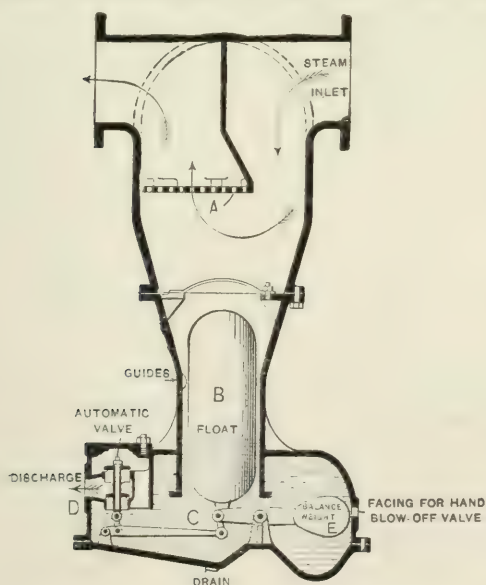


FIG. 10. SEPARATING APPARATUS IN STEAM PIPE.

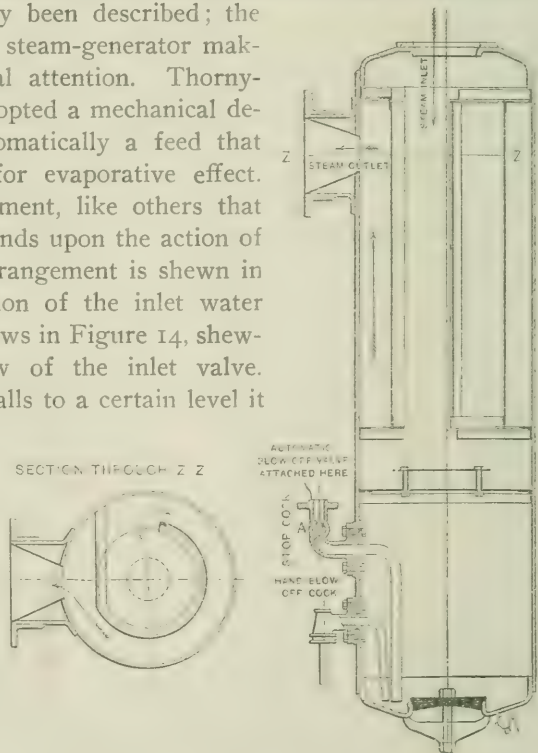
this float, with the associated lever C, opens the ejection discharge valve D; the water is then forced out and the balance weight E recloses the valve D. The water discharge can also be effected by hand. It is advisable that the apparatus should be made of gun or other incorrodible metal.

Belleville's auxiliary cylindrical separator is shewn in Figures 11 and 12, the direction of the steam passing through the apparatus being shewn by arrows. A circular division plate intervenes between

steam inlet and outlet. It has closed ends and an opening on one side, as shewn in horizontal section, Fig. 11. The water accumulates at the bottom of the vessel, and when it attains a certain height a float lifts an escape valve and the water is forced out. I have already strongly emphasised the importance of using dry steam, and the steam-pipe connections between steam generator and steam engine should never be permitted to act as condensers under any conditions; adequate jacketing should be provided to prevent this. My own system consists in the employment of a special oil or glycerine which is heated up to the temperature of 350° F. This fluid circulates not only through the jacket, but through a special tube placed in the centre of the steam space itself.

Turning now to automatic feed-water regulators, we come upon a field in which much more study has been expended upon the small-tube than upon the large-tube boiler.

Belleville's arrangement for automatically supplying his generator with water has already been described; the other large-water-tube steam-generator makers rely upon personal attention. Thornycroft, however, has adopted a mechanical device for securing automatically a feed that exactly compensates for evaporative effect. Thornycroft's arrangement, like others that will be described, depends upon the action of a float; the general arrangement is shewn in Figure 15, the direction of the inlet water being indicated by arrows in Figure 14, shewing an enlarged view of the inlet valve. When the steel float falls to a certain level it opens the inlet valve, an arrangement of levers permitting this action; the feed water flows into the water drum until the normal water level is obtained. The counterbalance weight closes the valve when the influence of the float is re-



FIGS. 11 AND 12 BELLEVILLE'S AUXILIARY CYLINDRICAL SEPARATOR.

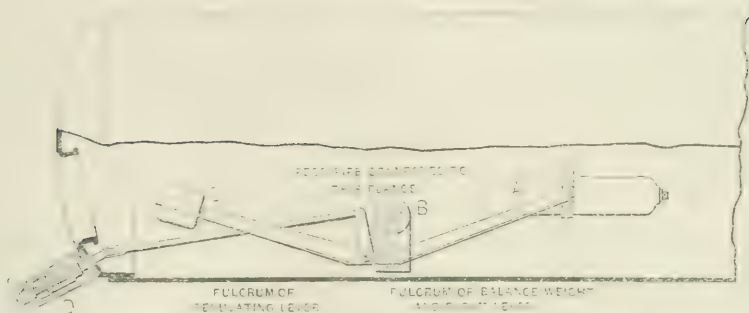


FIG. 12. THE YARROW AUTOMATIC FEED-WATER REGULATOR.

moved. The arrangement is also regulated by means of an externally placed hand wheel. In Figure 13 the float of steel is marked A, the feed-water valve B, the counterbalance weight C, the hand regulating wheel D. Yarrow, like Thornycroft, places his automatic feed gear inside the steam-and-water drum. It may be stated here that Yarrow does not on principle advise the employment of automatic feed arrangements. He considers they carry more danger with them than is compensated for by their advantages. Yarrow's arrangement is distinct from those already described; the action depends, of course, upon the rise and fall of the water in the steam-and-water drum. If the water falls below its

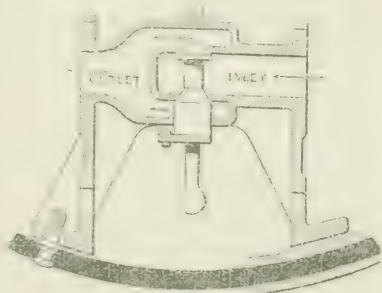


FIG. 13. ENLARGED VIEW OF THORNYCROFT INLET VALVE.

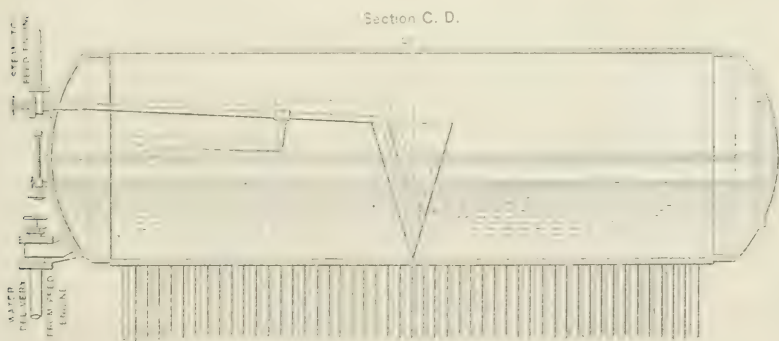


FIG. 14. YARROW AUTOMATIC FEED-WATER REGULATING SYSTEM.

proper level, steam enters a pipe leading to a pumping engine, which is actuated at a high velocity until the water in the generator is raised to the proper or normal level. When the water reaches the orifice of

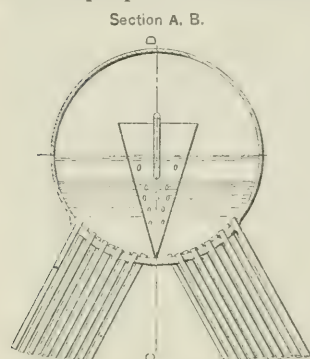


FIG. 16. YARROW SYSTEM.

the internal steam pipe which delivers steam to the pump, water flows along this pipe to the pumping engine and the pump works hydraulically, rapidly slowing down in speed. Provision is made for raising and lowering the internal steam pipe leading to the steam pump, in order to adjust the level of the orifice of the former and to satisfy the conditions of any height of water and method of working; the exhaust steam from pumps is directed into the feed suction and consequently acts as a

feed heater so that there is little thermal loss. If steam is used when the pump is working hydraulically, the hot water is simply taken from the steam generator and passed to the condenser through the escape valve. It will be seen that not only is the water, if below the normal level, rapidly raised to its proper height, but if the water is too high it automatically falls to the proper level. The figures are explanatory.

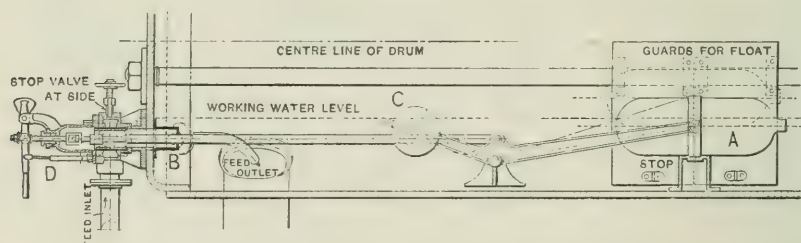


FIG. 17. LAIRD'S AUTOMATIC FEED-WATER-SUPPLY DEVICE.

Figure 17 shows the arrangement adopted by Laird for automatically feeding the Clyde water-tube boiler, one of the many modifications of the types of small-water-tube generators described. It will be seen to be similar in character to Thornycroft's, the disposition of the levers and the fulcrum being, however, different. The other modification is in the feed inlet valve, which is of the circular-piston form and is placed externally, giving visual indications of its condition of opening or closing. The inlet valve is regulated by hand.

THE QUESTION OF THE COST OF HIGH-SPEED TRAINS.

By Charles Rous-Marten.



IT may be as well to state plainly at the outset that, in considering the question whether high speed pays on a railway, I have no intention of inflicting on my readers huge masses of indigestible statistics. Voluminous tables of figures are sometimes useful and occasionally instructive, but they provide the dulllest of "dry" reading, and the object aimed at can be attained just as surely by means less painful to the reader. A better plan, I venture to think, will be to view the question from its practical aspect in the light of the salient general principles which may seem to have been established as the result of definite experience.

Now, in seeking to answer the question which forms the title of this article, we are met on the threshold by another question necessarily precedent to the solution of the problem. That is: What *does* it cost to run fast trains? And before we can tackle that problem with any hope of success we find ourselves compelled to be clear in our own minds what items go to make up the actual cost and the excessive cost—if the later exist—of high speed.

Here the enquirer promptly encounters a whole army of confused and contradictory opinions. But he will almost certainly find in the forefront of this army the confident allegation that "*high speed involves increased consumption of fuel.*" Does it? I will take that point to begin with. Why should increased speed involve augmented consumption of coal? Mr. Delano set himself, some months ago, to answer the whole question, but, as Mr. Angus Sinclair justly remarked, in the result he merely stated the problem which still remains unsolved. It is, of course, quite easy for flippant frivollers to interject offhand in their delightfully cocksure and question-begging style: "Why, of course, if you run faster you must use more steam, and if you use more steam you *must* use more coal!" Surely the *non sequitur* is

Mr. Rous-Marten's review is a striking presentation of the idea that intensified production is the absolute requisite of economy, just as truly when the thing produced is transportation as when it is mechanical apparatus. "The largest result in the shortest time" is the goal of modern industrial effort. The ultimate saving enormously repays the incidental expenditure. "Time is the one thing whose loss is absolutely irreparable."—THE EDITORS.

apparent. Does not the necessity of burning more coal depend very largely on the load you have to haul, and the road over which you have to haul it? If this be admitted, and as a matter of truth and honesty there is no alternative, then it is conceded *ipso facto* that there are other elements than that of mere speed to be taken into consideration. For example, would it use more coal to run on the level a 50-ton train at 60 miles an hour, or a 300-ton train at 55? Or would it cost more in fuel to haul a train *up* a one per cent. grade—1 in 100—at 50 miles an hour, or *down* at 75? No educated person, whether a professional engineer or not, will hesitate for one moment to answer in each case negatively. So then, ignoring for the present all other conditions, we are brought face to face with the plain fact that increased speed is only one of at least three elements that have to be taken into account, and that its influence on the whole question is absolutely relative to the proportional prominence of the other elements.

Having reached this stage in the investigation, I am enabled now to narrow down the issue in its first phase. Why should the haulage of heavier loads at higher speeds or up steeper grades involve increased consumption of coal? To this there is but one answer possible: Because the *resistance* is increased which has to be overcome by the engine. But then another query, and a very awkward one, thrusts its head obtrusively to the front: "What is the nature and amount and operation of the resistance encountered?" Ah, there we are faced by a puzzle which has hitherto proved insoluble. I am fully prepared for indignant counter-protestations. I am well aware that many various and discrepant solutions have been offered to the world, but as they *are* various and discrepant it is at least clear that each cannot be the true solution or the last word in the question. I am familiar with the earnest and able efforts made by Clark and others to settle the point definitely, and with their utter failure to achieve any approach to absolute finality. Even the latest proceedings of some eminent engineers with respect to atmospheric resistance show that the question of train-resistance is still in its infancy.

There are, however, certain broad facts with which one may deal in considering the whole subject from the practical viewpoint as distinguished from that which is merely academic and dialectic. Nobody will deny or dispute that *in certain circumstances* augmented velocity can be gained only at the expense of augmented coal-consumption. If you desire to force an express of a certain weight up a one-per-cent. grade at 50 miles an hour, instead of 40, you can only do so by means of increased power obtained through increased consumption of fuel.

That is quite clear. Everybody knows that and nobody disputes it. But is the case the same down a falling grade of 1 in 100? That can only be if we assume that high speed becomes more and more difficult as we descend a long one-per-cent. down grade, and that the resistance encountered becomes more and more severe the longer and faster we descend. But even the veriest tyro in railway matters knows that the reverse is the case, and that so far from increased effort being needed to accelerate the pace after some distance has been run at high speed down a falling gradient of 1 in 100, the engine-driver usually has to shut off steam and often to apply the brake slightly or moderately to prevent undue acceleration, that is to say beyond the limits fixed. Manifestly, then, his sole consumption of fuel at all would be in such a case for the working of the brake to reduce his speed, not for any purpose of augmenting it.

I have taken a one-per-cent. grade as a convenient arbitrary datum, but obviously the same rule would apply to other gradients, with more force the steeper, less force the easier they might be. But now let us take the absolute medium between the rising and the falling grade—the dead level. Is it a fact that fuel-consumption increases *pari passu* with increase of speed on an absolutely level line? Those theorists who delight in the Montague-Tigg kind of formula, "a figure of 2 and as many o's as the printer can get into the line," will instantly trot out their pet hack, the formula that "*the resistance of trains increases as the square of the velocity.*" To this I rejoin that it may do so in certain cases, that is to say, in certain circumstances and under certain conditions, but that the amount of resistance is not fixed and unalterable; it varies as do the conditions under which it is run. It is not proved and never has been proved that under all conditions the resistance of a train increases with the increase of speed. I do not mean simply *pari passu*, but even at all. It is not established that in certain circumstances the resistance does not diminish in some degree as the velocity increases. Observe, I merely say, "it is not proved." Neither is the contrary. The entire question is an open one. But it is at least fairly open to doubt whether, after a particular velocity has been attained, the rate of increasing resistance, and even the amount of resistance itself, do not steadily decline. This has been found definitely to be the case in certain instances. Why should it not be so? The reply will be that every source of resistance is necessarily magnified by augmented speed. No; not necessarily, by any means. For example, on a falling grade you have the force of gravitation working in your favour instead of against you, as you have when you

are going up-grade. The head resistance of the atmosphere is virtually negligible. The side friction of the train against the air is not a formidable factor. Friction of the revolving parts and the shock of the reciprocating parts are doubtless enhanced in some degree, but to what extent is not authoritatively established, and even in these cases it has yet to be clearly shown that a very high rate of speed does not operate with regard to friction of parts, providing these be well designed and adequately lubricated, much in the same way as a skater skims over thin ice with safety if his pace be fast, whereas he breaks it and is submerged if he try to cross it slowly. Moreover, in this case and also that of the reciprocating parts, there are plenty of devices well-known to mechanical engineers by which these drawbacks can be minimised, if not avoided. If a high piston-speed be objectionable—which is at any rate a matter strongly in dispute—it can be lessened either by shortening the stroke or by enlarging the driving wheels. The shock of reciprocation is a greater drawback, but it always must exist in some degree, and there is no proof that its severity is proportionately enhanced as to its obstructive effect by augmentation of velocity. In fact, if that part of the alleged increased cost of higher speed which is due to more fuel being burned be caused by enhanced resistance, it is evident that this does not exist in the descent of fairly steep inclines, that its extent upon the level is dubious, and that it acts with certainty only in ascending up-grades, while here it is affected by various conditions outside of the speed question.

A contention is often based upon maritime experience of the large additional coal consumption which is needed to secure an extra knot per hour when a very high speed has been reached—that this must also be the case on a railway, and that every mile per hour above 60 or 70 is gained only at a cost in fuel far exceeding that by which an additional mile of speed would have been got at 40 to 50 miles an hour. But those who argue thus totally forget the essential difference in the conditions. A steamship has to force her immense bulk through a very dense resisting medium, which obstructs her bow and clings adhesively to her sides. There can be no valid comparison between such a condition of work, and those which obtain in the case of a train rushing through the rare and elastic air. Indeed, some comparatively recent experiments have afforded strong grounds for believing that when a train is flying along a level or slightly falling road at a speed of 60 to 70 miles an hour, it takes a comparatively small exertion of locomotive power to add materially to that speed, the main, if not the sole, obstacle to still higher rates than we have yet seen being

not the resistance of the train, or the friction of the wheels and of the revolving parts of the engine, or the alternate shock of the reciprocating parts, but simply *back-pressure*, the backward obstruction of the used steam in the engine cylinders.

Coal consumption forms the subject of periodical returns on most railways, but except as to its aggregate amount and to its amount per engine-mile, these returns afford little, if any, useful information. Certainly they furnish no guide whatever as to the cost in coal of high speed. Two English railways have often been instanced as cases of relatively small consumption of coal being associated with a specially high average of speed. It is retorted by those who believe increased speed to involve large augmentation of coal-consumption, that this smallness of coal consumption on those two lines was due to the superior excellence of the locomotive designs. Very likely; but if so, if it prove anything, it proves that the greater fuel-extravagance of other lines, proportionately to speed, was due to the locomotive designs, not to speed, and that if an engine be well designed it may burn no more coal per mile at 70 miles an hour than another of inferior design at 50. At any rate, it adds another to the numerous list of qualifying conditions that affect the question of the relations between high speed and proportionate consumption of fuel. It is entirely a matter of circumstances and conditions, not one of mere speed alone.

But it may be urged—has been urged—that high speed involves other excesses of outlay, such, for instance, as the cost of better permanent way, rolling-stock, and signalling apparatus, and higher wages to better officials. To this I should answer at once that a railway company compelled to incur these items of outlay on its main lines receives benefit rather than injury. It is all in the favour of a company to have the best possible road and rolling-stock and men and methods, and the system which pretends to secure economy by parsimony in this class of outlay usually results in the company having to pay very heavily sooner or later for its misdirected stinginess. In no case is the advantage of unstinted liberality in securing the highest excellence more pointedly manifested than in that of a railway. In lessened cost of repairs and reduced liability to accidents, with their resultant damages and compensation, the benefit of first-class plant and material and personnel is forcibly shown, and parsimony in any of these respects is the falsest of false economy indeed.

Another objection raised to high speed is that it causes delay to stopping passenger-trains and to goods traffic by necessitating much shunting to let the expresses go by. But this need not occur if the

line be capably and smartly administered. Passenger "slows" usually meet with delay because they are worked at stations in a dilatory manner, all smartness being reserved for the expresses. Get them away promptly and punctually, and they will neither block the expresses nor need frequent shunting themselves. As for the goods traffic, it can be dealt with in either of two ways. One is to double or treble or quadruple the road, as is much done in England; to work the goods traffic in small waggons and relatively short trains, using proportionately short sidings, etc., and to keep the "slow" trains constantly lumbered up. The other plan, as practised largely in America, is to employ engines powerful enough to haul huge trains of large waggons at good speed and controlled by continuous brakes, so as to get the traffic out of the way as quickly as possible. This is done also to a considerable extent in France. Here again the difficulty is one of *management*, not of speed.

Now, however, I come to the kernel of the whole matter. Why should high speed be employed at all? Why should railways run faster than omnibuses or even than a walking pace? Why should not all merchandise and produce be conveyed along roads or canals? The entire freights of the whole world could be covered by horse-drawn vehicles. It would merely be a case of multiplying horses and vehicles, and then the farmers, too, would thrive through the demand for fodder, etc. Imagine such a suggestion being made to any practical man! Would he not instantly shriek in horror that the world's business could not possibly be carried on under such conditions, because of the inordinate time that would be occupied both in travelling and in carriage of goods, owing to the pace being so slow? Exactly; and there you get the *raison d'être* of railways—their speed. It is because they can convey persons and goods with such swiftness that they have become absolute necessities of life, and have metamorphosed the entire face of the civilised world—much of the *uncivilised* also—in little more than half a century. The one motive power has been—Speed!

Now, I am fully prepared to be answered, "Oh, yes, of course that is true, but it is an over-statement of the case; surely there is so wide a difference between personal travel at 10 miles an hour and goods carriage at 4 miles an hour on the one hand, and modern express speeds on the other, as to render the two things wholly non-comparable?"

Not at all. I admit the extreme difference, but it emphasises the gist of my whole contention, which is that the high-speed question is purely one of degree and not of principle. Let us admit, for the sake

of argument, that high speed may involve large coal-consumption. I will point out one method by which coal consumption, engine repairs, and cost of signalling may be reduced by any railway company to absolutely *nil*. It is merely by ceasing to run any trains at all. Only, then, whence would come the dividends and interest upon capital? But if you admit that you must burn some coal then you concede the main principle, and it becomes only a question of degree: How much coal it pays to burn? Well, then, suppose we run the passenger trains at 10 miles an hour and the goods at 5—would *that* do? I discern a unanimous roar in the negative. Very good, then double those rates—make them 20 and 10? Still an unqualified negative! Passengers would declare they might as well walk or go in a 'bus, and traders would say they must shut up shop, as they could not get their goods in time to be of any use. Then, clearly, we are driven into the corner that we must adopt some higher rates of speed than these, and the only question remaining is *what rate will pay?*

But then we have to form a thoroughly distinct conception of what we mean by "paying." And I take it that if we turn and twist the problem round and round about to ever so great an extent, it will unavoidably resolve itself into the conclusion that there is *no* fixed rate of speed that is in itself an ideal; that the paying rate depends, and *must* needs always depend, upon the particular circumstances and requirements of each line, and that no hard-and-fast rule can be laid down on the subject that will be applicable to every case. The one rule which is of universal application is that it will pay to run on any line at any speed that attracts or retains or improves profitable traffic. If this should involve augmented consumption of fuel and larger working expenses under other heads, what matter, if the outlay yield a profitable return? Is it conceivable that the Atlantic City Flyers would be timed year by year at their unprecedented booked speed, unless experience had shown that such exceptional speed paid, or had the probable potentiality of paying? I think too highly of American business acumen to doubt for one moment that the Flyers were put on purely as a commercial investment, and I know that this investment has been claimed to be a success. Is it a mere coincidence that the fastest railway in Europe, the Northern of France, pays to its fortunate shareholders dividends of 15 to 17½ per cent., or that the two slowest railways in Britain have drifted into such a ghastly mess that their position and methods are constantly characterised in the public press as "The Great Railway Scandal?" I cannot think so. My experience convinces me that where you find consistently high speed

there also you find, as a rule, better permanent-way, better rolling-stock, higher efficiency, and—their concomitants—less proportionate cost of repairs and less liability for compensation on account of delays and accidents due to inefficiency.

But, beyond this, the supreme object of a railway company is to secure profitable traffic. The first merit that makes for this end is conveyance with swiftness. It is often said, very foolishly and thoughtlessly, that punctuality is more important than speed, and that it is preferred by travellers. I have characterised this saying as “foolish,” because it sets up an antagonism which has no real existence, and as “thoughtless,” because a moment’s thought would evoke the suggestion that punctuality is *a priori* more probable when high speed exists with its invariable accompaniments of superior discipline and habitual smartness, than where customary sluggishness in speed has developed a spirit of dilatory indifference. And experience demonstrates that such is actually the case in practice. The slowest railways in Britain are also the most unpunctual—“audaciously unpunctual,” as one writer has well put it.

It is unfortunate that the query: “Does high speed attract and retain and improve traffic?” can only be answered on the strength of circumstantial evidence. Nobody can prove absolutely that the improvement in traffic on a railway which has accelerated its services is directly due to such acceleration, any more than the converse could be demonstrated if desired. But undoubtedly there is a large weight of circumstantial evidence in the affirmative. I have been shown official and authoritative statements to the effect that the “Atlantic City Flyers” have given satisfactory results, and this is supported by the fact that the number of the “flyers” has been doubled this season. Also I have been assured, on what I have reason to believe to be good authority, that other accelerations in the United States have been followed by increased traffic. In Britain the accelerations of 1895 were accompanied and followed by a vast development of the Anglo-Scottish traffic. The presentation of such facts as these does, of course, involve the demand for proof that the results are “*propter hoc*” and not merely “*post hoc*,” that they are not the mere natural developments of trade, instead of being due to accelerated transit. I shall not shrink from this problem. It is one with which I am entirely familiar. But as I have already said, I can meet it only with circumstantial evidence, although I can also adduce some very strong *a priori* reasons why such results might be expected to accrue.

Circumstances bring me into communication with a large number

of people who leave London every year in the summer or autumn for a change of air and scene. Formerly they would go to the various seaside places or points of interest in England proper, or would even cross the Channel, but Scotland was to many an unknown land. If asked why they never visited Scotland, they invariably would reply that the distance was so great and the journey so very long and tedious. But since the accelerations of 1895—usually called “The Race to Aberdeen”—there has been an enormous expansion of the Anglo-Scottish traffic. For many weeks during July, August, and September the principal expresses, which have been more than doubled in number, have to be sent off day after day in duplicate and even triplicate, and I have known fourteen heavy expresses despatched on a single evening from one London station to Scotland, instead of the four shown in the time-table. But I may be asked how I know that the accelerations have done this. My answer is that the people who now go and formerly did not, have said to me that they had imagined the journey to be far longer and more tiresome than they found it actually to be, and that the truth was brought under their notice by the “racing” of 1895, and the subsequent acceleration of the regular trains. When they read that trains had reached Aberdeen—“*ultima thule*” in their previous ideas—from London in 8 hours 32 minutes by the West Coast and 8 hours 40 minutes by the East Coast; Perth in 7¼ hours, and Edinburgh 6 hours 19 min., and all this without the slightest hitch or mishap, they realised that neither the distance nor the journey was so very formidable after all. So they tried it, and having once tried it they now go to Scotland year by year, and will

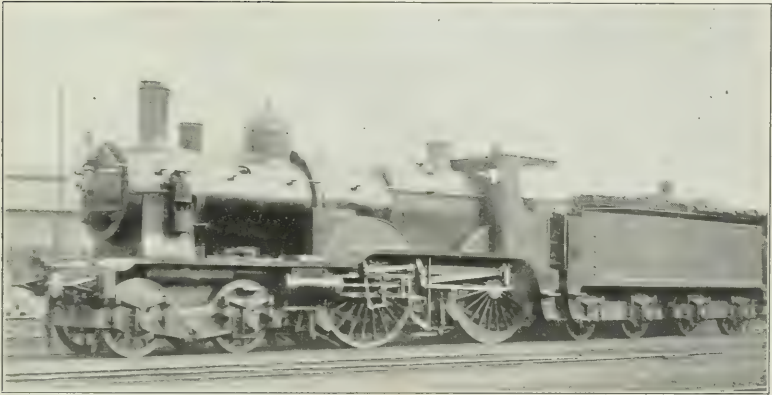


TYPE OF ENGINE MAKING THE FASTEST START-TO-STOP RUN IN AMERICA -
55½ MILES IN 20 MINUTES. ON THE ATLANTIC CITY FLYER.

continue to go. Is there any good reason to doubt that the experience of these particular persons who communicated it to me is also that of many others, and that here we have the true explanation of the last quinquennium's traffic developments? I think not. High speed is an excellent advertisement.

Nor is it difficult to see why this should be so. In the case of long-distance journeys, such as those between London and the Scottish Highlands, a saving of several hours of travel in the cramped compartment of the normal British "coach" is manifestly a boon—indeed, often renders the journey possible at all in the case of delicate or sickly people. But there are many other instances in which certain journeys are feasible only when done at a high rate of speed. Take the case of daily trips between a commercial city and a seaside resort. These are only possible to business men on the condition that they do not necessitate an excessive expenditure of time and strength in travelling. Of these circumstances the Atlantic City Flyer is the most brilliant offspring. By making a start-to-stop run of $55\frac{1}{2}$ miles in 50 minutes, the fastest in the world—at the average rate of 66.6 miles an hour—business men can travel between seaside residence and place of business in the even hour, including a ferry crossing. Following this example, the North Eastern Company, of England, have put on special "business expresses" to run between Leeds and Scarborough, 68 miles in 75 minutes, and following still farther behind we have the "London-Cromer special" and the "London-Brighton Pullman Limited," each averaging about 50 miles an hour. This does not compare brilliantly with the Atlantic City's 66.6, still the principle is the same, and it is manifest that this is being grasped, if slowly, by railway companies throughout the world. Time is the one thing whose loss is absolutely irreparable. The modern necessity in all directions is to save this priceless treasure. That can only be effected in travelling by celerity of transit, and while this is largely promoted by length of non-stopping runs, and by smartness of station work, the primary essential is—speed.

It is so, too, with goods traffic. Often the entire difference between profit and loss, between success and failure, depends upon the delivery of goods at a certain time. In all cases early and prompt delivery is of the highest importance. Hence we get the "express goods" and "important express goods" trains which in England are even worked by passenger-express locomotives and take precedence of some passenger trains. Nor is the advantage of rapid goods-transit confined to the consignors and consignees of freight. The railway company



TYPE OF ENGINE MAKING THE FASTEST START-TO-STOP RUNS IN FRANCE—81¼ MILES IN 81 MINUTES, CHEMIN DE FER DU NORD, AND 67¼ MILES IN 66 MINUTES, CHEMIN DE FER DU MIDI.

itself is a large gainer. By getting goods quickly along the line and therefore quickly off it, twice or thrice as much work can be got off one track as is obtained by the slower method. Consequently some British railways have to lay down four tracks, which even then are overcrowded by the traffic which another line works with ease and freedom on two tracks, merely because in the latter case powerful engines haul enormous trains at fast speeds, and so get the goods soon out of the way and leave the line clear for passenger expresses. The extent to which this is done in America has long been noted with interest in England, but the plan has not been copied for reasons of detail. But in France the practice is growing more and more, and those 50 six-wheel-coupled four-cylinder-compound bogie engines which I described and illustrated in *THE ENGINEERING MAGAZINE* of Feb., 1899, page 798, were built specially with this object, although they are now coming much into use for heavy passenger expresses. The other leading French lines are adopting a similar course, the object being augmented speed, notably up-hill, in the case of the passenger expresses, which are not allowed to run faster than 75 miles an hour down-hill, and so have to gain their time in the ascent of rising grades.

Thus, looking at the question from its various viewpoints, we obtain the same deduced result—that high speed on railways does pay if judiciously managed; that by attracting, maintaining, facilitating, and improving traffic, it enables railways to fulfil the function which forms their main *raison d'être*; that there is no proof that increased speed involves proportionate increase in coal consumption, excepting



CALEDONIAN RAILWAY ENGINE NO. 767. TYPE OF ENGINE MAKING THE FAST RUNS IN THE ANGLO-SCOTTISH SERVICE.

on rising grades; that with light loads any increase is very small, while such increase as is caused by hauling heavier loads more than recoups itself because it is incurred through increase of traffic, which it is the primary object of all railways to secure and the special function of high speed to induce; and that if the result of acceleration be unfavourable, the fault lies with the management, not with the speed.

I have frankly admitted from the outset that my argument would be, and must be, based on circumstantial evidence and on deductive reasoning, because no statistics exist, or are likely to exist, that constitute any valid proof one way or the other. I have not touched on the question of any danger attaching to high speeds, because all intelligent and well-informed readers will be aware that *there is none*, so far as mere speed is concerned. High speed is only run at risk on unsound or unsuitable roads, and in many cases it has saved a train accident from becoming a terrible catastrophe by enabling the train either to cut through an obstacle which else would have wrecked it, or to skim over a defective road with a minimum of danger, as in the St. Neots and Bytham mishaps on the English Great Northern Railway. In the case of the Preston accident a speed of only 40 or 50 miles an hour was sufficient to cause disaster through being run round a curve of only 154 yards' radius without check rail or proper cant; on another part of the same journey that train had often run with entire safety at 80 to 87 miles an hour under my own personal observation. Thus there is no factor of danger to be taken into account in considering the question, "Does High Speed Pay?" which I unhesitatingly answer in the affirmative.

The accompanying illustrations of the engines which make the fastest start-to-stop runs respectively in Britain, America, and France are reproductions of photographs by Mr. F. Moore, of Charing Cross Road, London.

GOLD MINING AND MILLING IN WESTERN AUSTRALIA.

By A. G. Charleton.

I.—HISTORY, POSITION AND GENERAL FEATURES OF THE GOLD-FIELDS.



FEW people living at the close of the nineteenth century, who take any interest in mining matters at all, can be unfamiliar with the name of Kalgoorlie—or, as it is sometimes written, Kalgurli (the name of a small hill close to the township); many, however, are at best but imperfectly informed of its remarkable history and surroundings.

A few years ago it was a small, unknown mining camp, in the "back blocks" of the crown colony of Western Australia, with a few canvas huts and shanties of corrugated iron dotted about; to-day, a mining town of the first importance, the name of which will be handed down to posterity as a landmark of British colonial enterprise, and as one of the most active centres of the mining industry. A tribute must be paid to its phenomenally rapid development, galvanized into industrial life, as it has been, by the confidence of the capitalist and the energy of the miner, of which I believe we see but the commencement.

A new gold-mining discovery always excites a broad general interest, because it offers a wide field alike for the profitable employment of labour and of such surplus capital as may be legitimately employed by people with means enough to embark money in mining. The allurements lie in the prospects it offers, if used with judgment, of a rapid accumulation of wealth, which the habitual investor in consols or gilt-edged securities neither requires nor is ever likely to realise. But beyond this, Hannan's (as Kalgoorlie is sometimes called), possesses a

Australia is interesting from a mining point of view on account of the lateness of its appearance among gold-producing regions, of its dramatic leap into prominence, and of its peculiar climatic conditions imposing special problems. Mr. Charleton's paper in this issue is the first of a series which will deal with topographical, climatic, and geological features of the field, the engineering practice developed to meet the local requirements, and the methods and equipment of the largest and most characteristic Australian properties.—THE EDITORS.

special interest for engineers, owing to the unique character of its surroundings and to its telluride deposits, which have entailed modifications of ordinary practice in developing and working them, and brought to light various new and interesting facts, from a geological, engineering, and metallurgical point of view. The circumstance that capital has doubtless been wrecked on its "reefs" by crazy speculators is not, generally speaking, the fault of the field, the geologist, or the miner; it is attributable chiefly to "market influences," coupled with neglect of the ordinary precautions which control the operations of prudent business men, as distinguished from the unwary mining speculator, who comes to grief through ignorance of the first principles of all successful business, for want of a well-organised intelligence department.

The object of this article is to present a sketch of the conditions under which mining has been and is being carried on at Coolgardie and Kalgoorlie, the two premier gold fields of the colony. The material is drawn partly from personal experience, partly from papers published by various societies, and journals not generally available for reference, and partly from notes supplied most kindly by various professional friends and mining companies, from the published annual reports of mines, and from government publications.

It was not till long after William Dampier landed on the west coast of Australia, in 1688, in company with the mutineers of the *Cygnets*, that gold mining sprang actually into existence, though he is credited on his return from England in the *Roebuck*, a year or two later, with the discovery of gold on the northwest seaboard, which is marked on old Dutch or Portuguese maps *Provincia Aurifera*. Later on, in 1847, Mr. John Calvert, visiting Exmouth Gulf in the *Scout*, again drew attention to the fact that the district was gold-bearing, bringing back with his specimens, on the strength of which he endeavoured to form a company in 1849, but failed to do so.

Proof of the existence of gold in paying quantity dates back, however, only to 1886, following upon the issue in 1884 of a map by Mr. E. T. Hardman, then government geologist, showing places where gold was likely to be found; this was after his return from a prospecting expedition to the Kimberley district, in 1882-1883. The Kimberley field was subsequently proclaimed in May, 1886, when the first "rush" took place; whilst Yilgarn was next discovered by Anstey in 1884; but it was not till May or June of 1892 that Bayley and Ford, starting from Southern Cross, set out on their eventful expedition, which resulted in the discovery of the Coolgardie gold field, where

they secured some 2,000 ounces of gold by "dollying."* This last discovery imparted an impetus to prospecting further afield, and Kalgoorlie was located by Patrick Hannan's party in June, 1893—an historical event which has proved probably as important to Western Australia as Marshall's discovery of gold in 1848, at Sutter Creek, was to California.

There are now seventeen recognised gold-fields in Western Australia, viz.: (1) Kimberley; (2) Pilbarra; (3) West Pilbarra; (4) Ashburton; (5) Gascoyne; (6) Peak Hill; (7) Murchison; (8) East Murchison; (9) Mt. Margaret; (10) Yalgoo; (11) North Coolgardie; (12) Yilgarn; (13) Coolgardie; (14) Broad Arrow; (15) East Coolgardie (better known as Kalgoorlie); (16) North-East Coolgardie; (17) Dundas. Their general position is shown on the accompanying map. I need only add that they are divided into sub-districts, being dotted with various independent mining camps.

The discovery of these gold-fields was in some instances not altogether without romance, notwithstanding their prosaic surroundings, perhaps in no case more so than in that of West Pilbarra, of which I may quote the story as commonly told. It appears that a discerning youth of tender years picked up a stone to throw at a cow (some say a crow), and noticing that it contained gold, reported the fact to the "Warden." This gentleman was so excited at the news that he flashed the intelligence by wire to the then Governor of the Colony, informing him that a lad had picked up a stone, to throw at a crow—but forgetting to add that he had seen gold in it! The Governor, much surprised, but moved by curiosity, wired back: "Yes; and what happened to the crow?" (or cow). This elicited explanations which led to the proclamation of the district as a gold-field, and in consequence of the rush that followed in the same year (1888) 3,493 ounces of gold were obtained, valued at £13,273, early attention being drawn to the district by the discovery of several large nuggets, one of which weighed 140 ounces.

The North-East Coolgardie field, to which this and subsequent articles will be devoted, covering as it does only 632 square miles, is with one exception the smallest of the above-named seventeen gold-fields, which possess a total area of 324,560 square miles, proclaimed

* John Ford made the first discovery of gold, near the Coolgardie water hole, picking up a piece weighing about half-an-ounce lying on the surface at a spot afterwards known as "Fly Flat." Messrs. H. M. Lefroy, in 1863, C. C. Hunt in 1864, J. Forrest in 1871, E. Giles in 1875, and D. Lindsay in 1891, who had previously visited the district, seem to have been unaware of its auriferous character, though Hunt discovered some outcrops of quartz near Hampton Plains.

as "open for location." Nevertheless, it has the enviable distinction of a larger output of the precious metals than all the other fields combined, hence its importance. Up to December, 1899, Hannan's, in fact, is credited with an output of 1,819,021 ounces of gold, produced in less than $5\frac{1}{2}$ years. The output of the whole of Westralia (Kalgoorlie of course included,) from 1886 to the end of December, 1899, is placed at 4,336,679 ounces, 8 pennyweights, 4 grains, which, calculated as having an average value of £3 16s. per ounce, represents £16,479,383 8s. 6d.

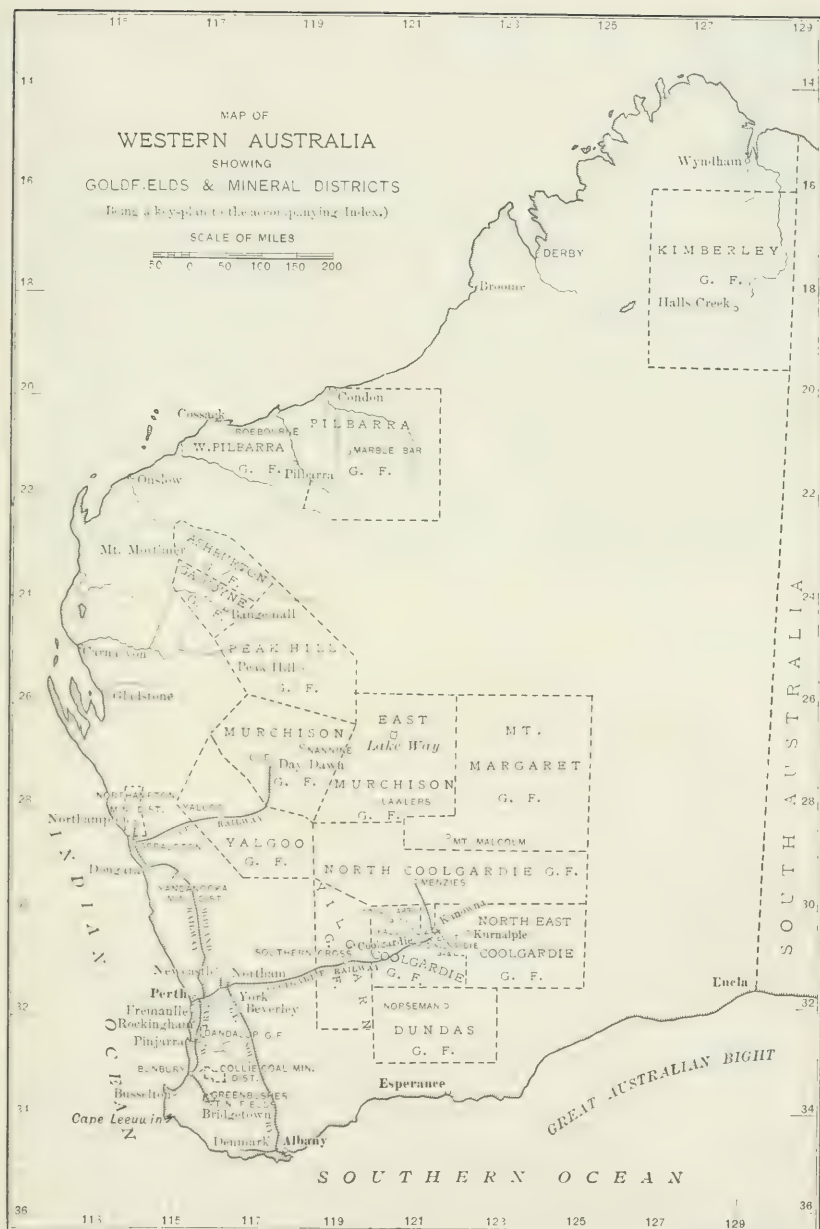
The colony of Western Australia, which comprises all that part of the Australian Continent west of the 129th meridian, has an aggregate area of 975,920 square miles, half of which is within the tropics, and whilst the interior is dry and hot and subject to very sudden changes, the coast is warm, with a rainfall varying from 20 to as much as 42 inches at the Canning waterworks in the Darling Ranges. The census in 1895 gave Western Australia a population of 101,235, but it must since have grown much larger, being estimated at 170,000 in 1898. The revenue for the six months ending June 30, 1899, was £1,278,139, against which is set an expenditure of £1,201,341.

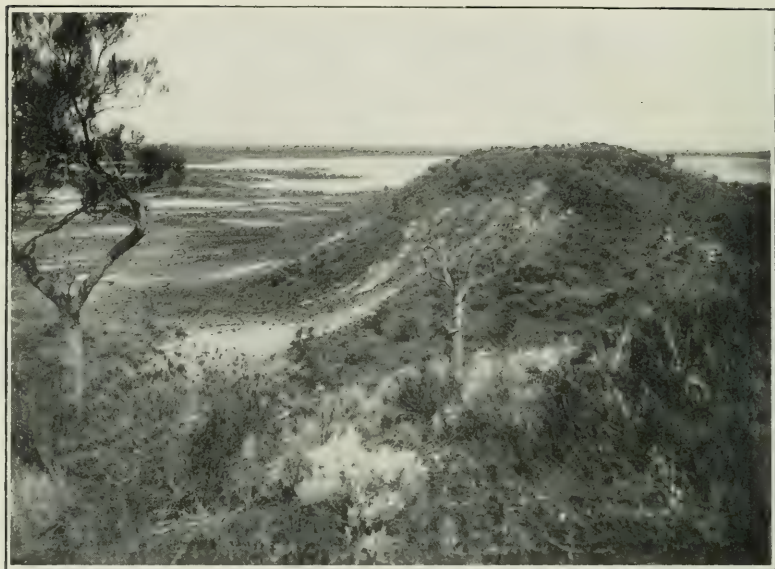
The dividends paid or declared by British-owned Western-Australian mining companies for three years are officially given as: 1897, £475,150; 1898, £770,829; 1899, £2,168,556, showing a rapid and gratifying increase. Total, £3,414,535. The port of Freemantle is distant only about 12 miles from Perth (the capital of the colony) but up to 1898 all mails and passengers for the gold fields were landed at Albany on St. George's Sound, which is connected with Perth by railroad,* the distance between the two places being 338 miles.

Kalgoorlie lies east (slightly north) of Perth, 315 miles from Spencer's Brook, a junction on the Perth-Albany line, 58 miles east of Perth, the distance by rail to Kalgoorlie from Perth thus being 373 miles, and from Albany 594 miles. The time taken by express in one case is about $18\frac{1}{2}$ hours, in the other 27 hours, if, as possibly sometimes happens, the trains run up to time.

The North-East Coolgardie gold-field is, however, within 200 miles of a port on the coast, at Esperance Bay, with which it must inevitably be ultimately connected by rail; once the powerful interests opposed to the construction of an outlet on the south coast can be overcome, it must cheapen and facilitate communication with the

* The gauge of the West Australian railways is 3 feet 6 inches, and they are mostly single lines, the rails weighing $46\frac{1}{4}$ pounds per linear yard. The cost of construction has varied from £3,600 on the Midland to £5,088 on the Government lines.





LAKE LAPAGE.

field, benefiting at the same time Dundas and the districts in the south of the colony.

The line from Perth gradually climbs the Darling range from the coast, a rise of about 1,000 feet, till it reaches the table-land of the interior—Spencer's Brook being 520 feet above sea level—from which point the line rises gradually until it reaches an elevation of 1,240 feet at Kalgoorlie.

This area forms a plateau, presenting a succession of ridges which have a gradual north-and-south direction, undulating like the surface of the ocean after a gale. Their crests, which are separated from one another by shallow valleys varying in width from a mile or less to ten miles or more, frequently consist of domes of granite, laid bare and polished by the wind-driven sand, whilst here and there an iron-stone "blow" breaks the monotony of the surroundings by its greater irregularity.

The "lake-beds," coloured blue on maps, are shallow basins with clay bottoms, dry as a rule, though perhaps containing an occasional pool of brine, or brackish water, which lingers there after the rainy season, giving rise to a so called "soak," where water has accumulated in a depression and is obtained by digging through the covering of sand. The streams, which really run only for a brief period after heavy rains, are really sandy channels sculptured out by the drainage

system of the country, marking what may once have been the course of ancient rivers, of which a mere trace remains unobliterated by denudation.

Taking a line from Lake Darlôt to Dundas (which would average about 1,400 feet above the sea) as the axis of the plateau, for 50 miles on either side there is but slight variation in altitude, and the general character of the country is everywhere very uniform. The land falls away from this central dome eastward, until the younger horizontally-bedded rocks of the Great Victoria Desert are reached, and to the west and south, to the Indian and Southern Oceans. The general impression is that of an endless plain with gentle undulations, the depressions of which are filled with the products of erosion.

In the interior the miner is dependent for all his supplies of natural drinking water on an occasional well, "clay-pans," and the rock-enclosed "water-holes," which are found in hollows exclusively in the granite. In the absence of well-defined water courses, the rain water is largely absorbed by the porous sandy soil, except after heavy storms, when large tracts are covered by sheets of water which gradually soak away or drain down to one of the aforesaid "lakes."

The rock formation of this plateau consists mostly of granite, pierced by igneous intrusions of diorite and kindred plutonic and volcanic rocks—porphyry and andesites, associated, it is said, in places with tuffs, which Mr. T. A. Rickard states have in some instances been mistaken for sedimentaries. He remarks, "There are no fossil-bearing



AN AUSTRALIAN WATER HOLE.

ing rocks, such as would afford a datum-line from which to measure the relative geological age of the prevailing formation. The age of the rocks of the Coolgardie area can only therefore vaguely be described as Archæan." *

Notwithstanding, however, some of the natural drawbacks I have referred to, Western Australia is not by any means such a bad place to live in as many other parts of the world, as it possesses several inestimable advantages—rich gold-fields, a progressive Anglo-Saxon population, handsome towns, and a climate which, if not entirely free from dust, is at any rate healthy, if proper sanitary precautions are taken.

The dust-storms, which rage for days at a time, are certainly a nuisance, but a secondary source of annoyance compared with the bush-flies,† which give rise to the common complaint of "bungeye," a painful swelling of the eyelids. Scorpions, centipedes, snakes, and



THE DEVIL'S ARCH, NIAGARA.

"red-spiders" are more often heard of than seen, and the smaller forms of irritating insect life are those that are most to be dreaded. The rainfall varies considerably; thus, while at Kalgoorlie it only amounted to $2\frac{3}{4}$ inches in 1894 (an exceptionally dry year), in 1893 it came to $4\frac{1}{4}$

* The Alluvial Deposits of Western Australia, by T. A. Rickard, A. R. S. M., Trans. Am. Inst. Mining Engs., Oct., 1898.

† It is said that Bayard's eucalyptus oil, distilled from *eucalyptus maculata* (var. *citrodora*) will keep off flies and mosquitoes.

inches, but scarcely ever exceeds 8 inches. The average is probably between 4 inches and 7 inches. That the climate has not always been so dry, however, is evidenced (as Mr. E. S. Simpson, the government mineralogist, points out), by the discovery near Coolgardie (which is about 24 miles from Kalgoorlie), of a thick bed of brown coal containing numerous fossil fern-leaves.



ON THE BULONG ROAD.

The local meteorological conditions at two places as close even as Coolgardie and Kalgoorlie—the latter town being situated in latitude $30^{\circ} 45'$ south, and longitude $121^{\circ} 30'$ east—are by no means identical. In striking contrast to the rainfall, the rate of evaporation is estimated as equivalent to 7 feet per annum.

It must not be supposed, however, as might be expected under such climatic conditions, that the general aspect of the country is that of a South African desert. Far from it, as nearly the whole plateau is covered with low "scrub" and "bush," in which the ti-tree and mulga (species of flowering acacias), salmon-gum (eucalyptus salamonophlia), and gimlet-wood predominate.* This bush remains green all the year round, individual trees attaining a height of 20 to 80 feet, and 3 inches to 3 feet in girth. Here and there may be noticed a patch of "nigger-head," a dwarf palm, crowned with a cluster of leaves like the head-dress of a South-Sea islander, as well as other curious tree-shrubs, such as the sandal wood, which flourishes in the sandy interior.

METEOROLOGICAL CONDITIONS AT COOLGARDIE, 1897.

Month	Temperature					Temperature of Dew Point.		Rainfall	
	Mean Max. °	Mean Min. °	Highest Min. °	Lowest Max. °	Greatest Variation in one day °	9 A. M. °	3 P. M. °	Total inches	Days
January	94.1	63.2	104.3	53.0	42.2	53.5	54.0	.56	4
February	89.4	58.5	104.6	47.4	47.3	51.8	53.6	.54	5
March	85.6	57.7	98.4	50.0	41.0	49.2	55.0	.10	2
April	81.2	53.9	96.1	39.1	36.5	51.3	57.4	.01	1
May	71.4	46.6	88.4	38.2	41.5	46.9	53.5	.09	3
June	62.9	43.9	71.2	31.5	29.8	44.2	49.7	1.04	9
July	65.1	42.4	74.0	36.5	33.5	43.5	47.5	.34	6
August	63.8	41.5	81.0	33.0	34.6	40.8	43.7	1.08	10
September	75.0	47.5	92.0	35.0	39.7	43.7	49.5	.29	6
October	81.0	49.8	91.0	41.0	39.7	...	...	.06	2
November	90.6	58.4	105.0	47.3	44.6	...	...	.09	1
December	91.7	59.5	109.2	51.0	44.2	...	...	1.31	4
1898.									
January	97.6	65.1	111.2	54.0	43.2	60.1	68.2	nil.	..
February	89.3	62.5	107.2	48.0	37.7	57.0	60.2	.27	1

METEOROLOGICAL CONDITIONS AT KALGOORLIE, 1897.

Month	Temperature					Temperature of Dew Point.		Rainfall	
	Mean Max. °	Mean Min. °	Highest Max. °	Lowest Min. °	Greatest Variation in one day °	9 A. M. °	3 P. M. °	Total inches	Days
January	92.9	66.0	105.0	55.0	34.2	51.1	52.0	.38	2
February	88.2	61.6	103.0	49.0	34.7	51.2	51.5	.02	1
March	83.8	58.9	98.4	51.0	39.0	49.0	49.4	.52	6
April	80.0	55.9	95.4	38.8	32.8	48.0	46.8	.20	1
May	69.8	48.0	88.1	37.0	40.4	46.5	45.0	.10	1
June	62.9	47.4	73.2	36.2	30.2	46.4	49.1	1.26	14
July	64.4	43.3	74.0	33.2	29.8	42.8	43.7	.22	3
August	63.8	43.3	82.0	34.0	29.1	40.0	41.7	.65	9
September	74.2	48.8	90.8	37.2	40.2	41.6	43.8	.41	5
October	78.5	51.8	90.2	41.0	38.0	42.0	40.4	.11	2
November	90.2	59.0	103.0	48.0	49.0	46.8	48.7	.06	1
December	90.7	61.6	109.2	49.4	39.0	48.3	49.5	.82	4
1898.									
January	98.0	66.8	113.2	55.0	41.0	51.3	50.3	.02	1
February	90.5	63.4	109.8	48.2	38.6	51.2	49.9	.36	3

TABLE OF TEMPERATURE, RAINFALL, HUMIDITY, ETC., COOLGARDIE AND KALGOORLIE, 1897.

To the pedestrian compelled to "hump his swag" * the tracks or roads, cut through the "bush" with the conventional straightness of a Roman highway, are inexpressibly monotonous, and when an elevated point is reached, the eye sweeps over miles and miles of dull green forest, the only evidence of human surroundings, perhaps, a wisp of blue smoke from some distant campfire, or a deserted "mi-mi," † lately tenanted.

Many of the trees, however, shed their bark annually, when the new wood exhibits delicate tints of red, pink, salmon, and green, which affords a little variety. The thin, lanceolate, grayish leaves, which at times look as if varnished, give but little shade. The quandong and kroorajong, which grow in isolated spots, are said, however, to afford some protection from the blazing sun. ‡ The view in these forests extends for a few hundred yards only, and grass is frequently absent, or only to be found in scattered tufts—sand, boulders, or bare rock lying all around. In spring the forest land in places is, however, abundantly carpeted with brilliantly coloured flowers of the "everlasting" species, belonging to the genera *Helichrysum*, *Helipterum*, *Waitzia*, *Podolepis*, and *Angianthus*—"magnificent splashes of colour carpeting the desert with splendour," § but wholly devoid of perfume, and with the dry, brittle texture of immortelles.

An old man kangaroo, or wallaby, bounding off like a boy in a sack-race, a mob of cattle grazing on a "station," a troop of noisy parrots, the flight of a leisurely circling kite, or a laughing-jackass perched on a gum-tree, occasionally break the pervading solitude; otherwise the bush is a wilderness, seemingly devoid of life except when invaded by man.

The high elevation of Kalgoorlie, and its latitude (more than 30° south), no doubt account for the coolness of the winter months (July, August and September), when, as a rule, an overcoat can be worn with comfort except at midday. Even in summer, there 's a cool crispness of the air at night, though the shade temperature during December, January, and February is often very high. During a visit I paid to the field in 1898 the thermometer registered one day, January 9, as much as 113.5° F. in the Palace Hotel.

Typhoid fever and dysentery are the worst scourges in the towns,

* Carrying all his worldly goods on his back.

† A bush hut formed of four posts roofed with eucalyptus boughs with the leaves on.

‡ The valuable forests of jarrah (*eucalyptus marginata*)--which often attains a height of 100 feet with a diameter of 3 to 5 feet and is most useful for piles, wood-paving, etc., owing to its hardness and durability in water--are found in the southwest division of the colony, as also karri (*eucalyptus diversicolor*) which sometimes reaches a height of 250 feet.

§ T. A. Rickard, *ibid.*



A WILLY WILLY, OR REVOLVING DUST STORM

being more or less prevalent in the hot season, owing partly to the failure of sanitary arrangements to keep pace with the growth of population, to impure drinking-water, to the germs carried by dust,* and to personal carelessness of hygienic precautions: people leading sedentary lives, like bank-clerks, appear to suffer most.

In a climate of this description, the agencies of surface-erosion work for destruction as slowly but surely as the levelling action of socialism. The absence of ordinary evidence of water erosion, alternating drifts of sand and stretches of bare rock, bear testimony to the important part the wind has played (without counting the familiar

* In South Africa, dust is considered to be one of the chief causes of dysentery. The same is no doubt the case in West Australia.

trumpet of the company promoter), in the history of the West Australian gold fields. It has helped to carry the products of denudation, and liberated a great portion of their contained gold close to the spot from which it was originally derived—close, in comparison with what would have happened had the transporting agent been water. Wind, though usually an insignificant factor in its geological effects, has in this instance, as will be seen hereafter, played an important function, not only in the formation of local deposits of alluvial, but also in enriching the upper decomposed portions of the Kalgoorlie formations, its action doubtless extending over æons of time to produce these remarkable results. The effects produced by the constant wearing action of sand are shown by pieces of glass lying on the surface, which are invariably so scratched as to have a frosted appearance.

The violent dust storms, driven in gyrating columns or charging clouds across the surface of the "flats" and along the streets of Kalgoorlie, set in motion by the draughts that obtain on this elevated plateau, are an extraordinary sight, and show the amount of material that can be moved in this manner. The whirlwinds, veritable wind-spouts, termed by the aborigines "willy-willies," springing up suddenly, spin madly along, sometimes straight ahead, sometimes in circles, collecting the dust, sand, paper, and refuse they find in their track and sucking up all the loose objects they come across, move rustling and hissing along until, subsiding as suddenly and erratically as they arose, they deposit their burden of material, which weathering and erosion has disintegrated, far from its original cradle. As will be seen from the accompanying photograph, the "willy-willy," though more impressive, is perhaps less potent in its effects as a conveyor than the steadier and more continuous dust storms travelling straight along in one direction, and its action is chiefly disintegrating.

To illustrate the power of the wind—termed by geologists "æolian agency"—Mr. T. A. Rickard has pointed out that elsewhere in Australia fences more than four feet in height have been known to be buried in a little more than two years, while in Egypt sand storms bury the temple of the Sphinx every summer, and the road built by Ismail Pasha from the Mena House to the Pyramids is filled up with sand to the level of the six-foot parapet in less than 10 days!

But wind has done something more than merely disintegrate and transport the loose material lying on the surface: it has likewise "winnowed," and so *classified*, it. This is impressed on the observer travelling through the country, by acres and acres strewn with a sheet of angular fragments of white or coloured quartz, while close by patches of

WIND FORCE, 1897.

Month	Coolgardie				Kalgoorlie			
	9 A. M.		3 P. M.		9 A. M.		3 P. M.	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
January	3	1	3	0	2	1	3	3
February	4	2	4	1	7	2	7	2
March	3	2	3	1	5	2	2	0
April	4	0	3	2	2	1	9	1
May	8	2	3	0	5	2	2	2
June	2	1	3	2	9	2	5	2
July	5	1	6	1	3	2	4	2
August	5	1	6	1	6	2	8	2
September	9	1	9	1	6	2	9	2
October	5	1	8	1	7	2	6	2
November	6	1	9	1	5	2	8	2
December	9	1	4	1	2	2	3	2

Beaufort's scale of wind force is as follows:

Number	Description	Speed of Wind in Miles per Hour.
0	Calm.	3
1	Light air.	8
2	Light breeze.	13
3	Gentle breeze.	18
4	Moderate breeze.	23
5	Fresh breeze.	28
6	Strong breeze.	34
7	Moderate gale.	40
8	Fresh gale.	48
9	Strong gale.	56
10	Whole gale.	65
11	Storm.	75
12	Hurricane.	90

VARIATIONS IN DIRECTION OF THE WIND AT KALGOORLIE DURING SEPTEMBER, 1897.

9 A. M.		3 P. M.	
Direction of Wind.	Days	Direction of Wind.	Days
North	4	North	4
North to east	5	North to east	4
East	3	East	1
South to east	5	South to east	3
South	1	South	4
South to west	6	South to west	7
West	1	West	5
North to west	2	North to west	2

TABLE OF WIND FORCE AND DIRECTION, COOLGARDIE AND KALGOORLIE, 1897.

"black sand," glittering a steel gray in the bright sunlight, or blue-black when in the shade of a passing cloud, graduate off into beds of gravel and dust, in which one may wade up to one's ankles. The heavier magnetic or titaniferous iron-sand, the product of the decomposed diorite found close to the spot where it lies, though crumbled to powder, is scarcely affected by the wind which has collected and moved the quartz, detached from the stringers traversing the underlying rocks.

From the extent of the patches of iron-stone and quartz, collected in this manner, one might infer the probable existence of large masses of both near by, but the following extract which I may quote from Mr. Rickard's excellent paper shows that this is by no means always the case: "Owing to the extreme slowness with which denudation progresses in this arid region, and the consequent very gradual lowering of the zone of oxidation, the rocks exhibit above the drainage level a marked intensity of chemical action. The granite is kaolinized to an almost incoherent clay, and the diorite is rendered abnormally heavy in iron by the surface-concentration of decomposition products. And, as the rock is eroded, the quartz, on account of its hardness, persists, so that a series of small stringers eventually yields an accumulation suggestive of its derivation from a large mass." This, no doubt, partly accounts for many mistaken statements and disappointed hopes, to be found in prospectuses, where the prospector has not satisfied himself with more than a mere examination of the surface.

The foregoing process of concentration is not, however, confined merely to the accumulation and enrichment of detrital deposits; there is ground for believing it has affected the enrichment of the upper portions of the formations regarded as lodes in place, since gold particles, scoured off by surface erosion, have no doubt found their way down through minute fissures and seams in the dry kaolinised rock to considerable depths, and gold in solution has doubtless enriched the deposit still further from the surface.

In sampling long cross-cuts through the country rock, in several Kalgoorlie leases, Mr. H. C. Hoover mentions,* as confirming this conclusion, that "few assays were secured above the 100-foot level, which did not yield from a trace to 8 pennyweights of gold per ton. Yet in sampling cross-cuts at greater depths, traces of gold became smaller and smaller, until below the zone of kaolinisation, any trace of gold at all in the country-rock is rare."

* The Superficial Alteration of Western Australia Ore Deposits, *Trans. Am. Inst. of Mining Engs.*, Oct., 1868.

In the Croesus South United, for example, a cross-cut on the 100-foot level averaged 6 pennyweights per ton, no assay yielding over 10 pennyweights; yet a cross-cut immediately beneath, on the 200-foot level, averaged but 1 pennyweight 11 grains.

The government meteorological reports do not seem to indicate that the wind at Kalgoorlie blows steadily in any one prevalent direction, though Mr. Rickard states that his own observations would have led him to think that it followed as a rule a south-east north-west course, which corresponds with what I myself noticed; that is to say, from the Boulder township towards the Kalgoorlie. The difference in temperature between day and night in Western Australia has also helped in moulding its physiographical outlines, through the action of dew, which, like water, changing in volume with change of temperature, however minute the change may be, brings to bear on the rocks an enormous disintegrating effect, corresponding to the action of frost in colder climates, only on a lesser scale.

In the case of water, the point where detritus settles is governed by the size of the particles, the depth of the current, the slope, size, and course of the channel, as well as by nature of the bed over which it is moved. In the case of air, movement is restricted to shorter distances, and the sorting process produces a deposit of far less regular structure.

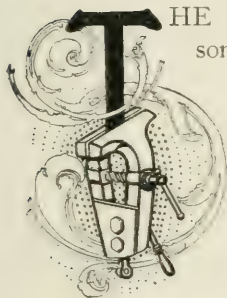
Where an outcrop of gold-bearing quartz follows the crest of a ridge, a thin covering of sandy soil will generally be found on its lee side, which thickens perhaps lower down to several feet. A section of such a deposit frequently shows on top a few inches of dust and sand, passing into compacted fragments of stone and quartz, bound together with stiff clay, forming an "agglomerate," locally known as "cement"—"an unclassified product of erosion" (as Mr. Rickard describes it). "lying close to the place of its origin, as a mere collection of unassorted débris."

The underlying rock is so softened by decomposition that it may be, and often is, taken for part of the deposit superposed on it, and if a shaft is sunk, it will penetrate often through feet and feet of this oxidised ground, till solid diorite or granite makes its appearance at a depth of from 50 to 200 feet, where water-level is reached.

My next article will deal with the geology of the Coolgardie gold-field and the method of working alluvial deposits in West Australia, known as "dry blowing."

THE APPLICATION OF PIECE WORK AND THE PREMIUM PLAN.

Communicated by Sir Benjamin C. Browne.



THE great importance of the satisfactory working of some system which will reward the workers for their skill or attention to their work, and thus encourage them to execute their work at the greatest possible speed, has long been apparent to the managers of engineering works.

Apart from the financial gain of an increased output, often at a less cost for labour, which should be the result of a piece-price or premium system, there is a certain, if more distant, gain in the superior class of workman which is produced. That the power of making higher wages by increased skill will gradually produce more and more skilled workmen none will doubt. But there are many cases in which, by short-sightedness or bad management on the part of the employers, more harm than good is done by substituting piece for time work. It is to the reason for some of these failures that I wish to draw attention in this article.

It seems hardly necessary to describe the principles of the piece-price or premium system, but in case there should be a few to whom these matters are more or less strange, it may be well to give a sketch of the best known of these systems.

First, then, there is the piece-work system which is most commonly used in English manufactories, by which the employees are paid so much for each piece on which they perform a certain operation. Some employers using this system pay a slightly increased price when the output from a machine rises above a certain number in a given time, as an extra spur to push the output, but this is not a common practice.

The accompanying article, while it has had the benefit of Sir Benjamin Browne's supervision and endorsement, is not his own production. It is based on a paper written confidentially for the British Government, by one of the first authorities on the subject in Great Britain, in connection with the work and reorganisation of the most important mechanical departments conducted under Government auspices.

The strictly confidential portions have of course been taken out, leaving a valuable summary of the whole question which is particularly interesting on account of the somewhat vague ideas generally prevailing as to the actual status of piece work in the English engineering industries.—THE EDITORS.

Secondly, there is the premium plan, about which so many able articles have been written lately. By this system the employees are paid never less than their time wages. Should they, however, do their work in less than a given time, they receive, as a premium, payment for some proportion of the difference between the time in which they did the work and the time given them for the work. Thus suppose a man working fifty-four hours a week performs an operation, for which the time given is nine hours, in six hours: he would at the end of the week receive payment for fifty-four hours' work plus a certain proportion of twenty-seven hours, he having saved three hours a piece on nine articles. The merit of this system, from the employees' point of view, is that if they are given a time to perform an operation which they consider too small, they can work at an ordinary time rate without loss to themselves. Looked at from the employers' side, it is seen that if work is done under the given time they receive not only the profit from the increased output of the machines, but also pay a smaller price for each piece.

A variation of the above method is the following: Suppose an engine is to be built to fill an order. An estimate is made of the total number of working hours required to complete it. When the engine is finished, the actual number of hours worked is subtracted from the estimated time, and some proportion of the difference—if the actual time is less than the estimated time—is divided amongst the men who worked on the engine, in proportion to the length of time they worked, and they receive pay for this time according to their rating. The advantage claimed for this system is that every man will try to make the other work as hard as, if not harder than, himself, it being greatly to each man's interest to prevent any slackness on the part of the others.

There are many other variations of the premium plan, and also of the piece-price system, but it is not necessary to discuss the variations in this article.

I think it is important to divide the working of the systems into two parts. The one, where the machines being worked are of the semi-automatic type, such as the modern form of capstan and turret lathe; and the other where the machines are of the ordinary lathe, or boring-machine, etc., type. In the first there is but little skill required by the operator. The tools should be set by skilled workmen, the machine being worked by unskilled hands at a low rate of pay.

The machine man's work consists in little more than pulling or pushing certain handles and fixing the work in the machine. So perfect are these machines now that the man should not require to use

any gauges on his work, it being quite sufficient for an experienced gauger to visit the machine every now and then to see that the tools have not worn too much. There would seem little difficulty in fixing fair prices for such a class of work. The time taken to do each operation can be easily found by watching a machine, if the operation be a short one, and judging if the man is doing his portion of the work as quickly as possible: or, in the case of a long operation, by calculation based on the feeds and speeds which can be worked by the machine on the piece of work in question.

Unfortunately the machines are not always kept up to their best working conditions. The foreman, or manager, allows them to get into a poor state of repair. He does not take the trouble to design really satisfactory tools for dealing with the work. The result is, the machines do not turn out such perfect work: the men require gauges, and file or scrape the work to fit the gauges. It becomes then a far more difficult matter to fix a fair price for the work: it degenerates into a kind of lottery. A man may get an easy piece, or a very hard one. Another evil is apt to creep in, a very bad habit which has long been in vogue in some districts, of settling a piece price in this way. A workman is allowed to make a certain number of articles on time, and then the foreman arranges such a price as will allow him to earn time and a half, i. e., if a man's wages are 6 shillings a day, and he makes one article working quietly, the foreman would give him 6 shillings an article and expect him to make one and a half a day on piece work, and so earn 9 shillings. This makes it to the man's interest to dawdle as much as possible over the trial articles, and also records the fact that at ordinary work a man is not to be expected to work to more than two-thirds of his best efforts. Bad enough in the case of hand work, but intolerable in the case of machine work.

But worse is to follow. It is then common for the clerks to watch the men's earnings, and if they find a man earns more in the week than time and a half, they therefore reduce his piece price. Obviously, therefore, the men take care not to turn out more work than will give them time and a half, and if they find means of doing work more quickly, they will only adopt it so far as it saves them trouble, and in no case will they utilise it to increase the quantity.

Very different from this is the practice in some American shops of paying a man an absolutely higher rate, if he turns out an excessive quantity, on the excess. Thus if, as above, a man gets 6 shillings an article and is expected to turn out nine a week, thus making £2 14s. od., and finds by increased energy or ingenuity he can turn out twelve, by

the bad custom mentioned above the clerks would reduce his price to 4 shillings 6 pence each, so that he would earn twelve times 4 shillings 6 pence (that is £2 14s. od.) as before. Thus it will be seen he gets no reward for his merit, only increased toil.

But on the American plan he would be paid 6 shillings for each of the nine articles, and for the extra three articles, perhaps 7 shillings each; so that his earnings would amount to a total of £3 15s. od. This is an increased inducement to a man to make efforts, and it pays the employers, for the three extra articles are made without any increase to their capital, salaries, or standing charges. Probably it would only be in the case of large and costly machine work that the extra payment would be actually as large as is indicated, but the same principle would always apply.

The bad customs above mentioned arise from the managers and foremen being too ignorant or too indolent to estimate by calculation what work ought to cost. To many this may seem a very exaggerated state of affairs, but I know it to be far more common than is suspected.

To show how utterly useless piece prices may become, I will give an instance which I heard not very long ago. Great pressure was brought to bear on a department of certain works, to produce a large increase of a very complicated article. Prices were reduced where possible, more machines put down, and yet the output seemed to rise very slightly. At last a man of some experience in such matters was requested to report what could be done to put things right. After looking carefully into the working of the department he reported much as follows: Many of the machines were in such a condition as to render it impossible to turn out good work without great care from the workman. The workmen were being paid for the number of articles passed through their machines, whether accurate or not. In some cases the prices were so low as to make it impossible for the men to make fair wages without turning out careless work, with the result that much of the work had to pass two or more times through certain machines, and other machines were employed entirely to correct errors in the work. Steps were taken to put the department into a better state of organisation. A sufficient staff of gaugers was employed, to gauge the work as it came from the machines. The workmen were paid only for the articles correctly machined. Some of the piece prices were increased. The result was an increased output of more than half, and the number of articles rejected for faulty machining decreased to almost nothing.

The important points then to be observed in working the piece-

price system on the semi-automatic machines are these: First, to keep the machines in a perfect state of repair; never to allow a machine to continue working if in bad repair, under the false impression that it cannot be spared. It is far more economical to stop the machine and overhaul it thoroughly than to allow it to go on running in a slipshod manner. Second, never to allow the men to get the impression that if they make more than a certain amount of money in a week their prices will be reduced.

Cutting down prices must be done with great caution. Men are usually amenable to reason if there is a clear case and their side of the case is considered, and especially if it is discussed with them. At one time the writer introduced a system, which worked very fairly, for introducing improvements. Suppose a better machine was got, it would be pointed out to the man that much more work should be done, but that as every novelty wants some nursing to develop it properly, the following arrangements would be made: "For about a month we will not alter the piece rate; get the machine into order and turn out all the work; make all the money you can during that time; but after that we shall reconsider it entirely." I have always found this inducement quite sufficient to make a man do his best, for of course the machine was got to make money for his employer, and he has no guarantee that he will keep the job after the month (or whatever the time is) has elapsed. Another excellent plan is to give the articles to the workmen arranged in trays, so that they can see at a glance how many they receive, and return machined. This also prevents the possibility of men or boys losing or throwing away articles they have spoilt by careless work. Lastly, gauge the work when it comes from the machines, and do not pay for the pieces which are incorrectly machined owing to carelessness on the part of the workman.

We now come to the far more difficult question of the working of the piece-price system or premium plan with machines of the ordinary type.

Here so much depends on the skill of each individual workman that fixing a fair price becomes a far more difficult matter. I think in this case the premium plan is the most satisfactory to work, as if a price is fixed too low the man still makes his time wages, and if, on the other hand, the price is too high, the profit is not entirely taken by the man. As a rule, it may be said that although this class of work requires more skill from the workman, it does not require so hard work. In fact, more depends on the brain of the workman than on his muscle. This being so, some method of payment which encourages

this action of the brain must be a most beneficial thing both to employers and employees. At the present time, when wages for one class of work are kept so much on a level for quick and slow workers, it seems most desirable that the quick workers should have some way of making extra pay, and of showing themselves superior to the others.

The question, then, is how to fix a time for a piece of work taking perhaps a hundred hours to turn, which will be fair both to the workman and the employer. There are many foremen and managers who believe they can tell by looking at the piece to be turned how long it should take to machine. They may tell how long it *will* take, but very rarely how long it *should* take.

In my opinion there is but one way of basing such a price, and that way is by simple calculation. Given a certain machine and a certain piece of work to be done in it, knowing what depth and feed the machine will take on roughing cuts, also what feed can be run on the finishing cut (the speed will depend on the material), it is then an easy matter to calculate how much time must be spent roughing off the material and how much finishing, making allowances for changing tools, gauging, and any work not done by self-acting feeds, such as finishing a large radius. After a little experience the time for machining very complicated pieces of work can be found most accurately. When this method is carefully applied some astonishing things are brought to light. Work which it is supposed is being done quickly is found in reality to be taking perhaps twice the length of time that it should. I have come across many cases where the men working on time and far exceeding the estimated time, have declared they were working as hard as possible, and trusted foremen have assured me the men could not do better; and yet when the operation has been carefully watched the estimated time has been easily reached.

I think that if the premium plan were adopted and the times fixed on the above method, a great saving would be effected in many English workshops. There is no doubt that this method of carefully estimating the times required leads us to the most efficient working of big machines: as the portions of work to be assigned to the various saddles of, say, a big lathe, are calculated so that no saddle has finished its work before the other, and one saddle can be used perhaps for a long self-acting run while the man is working the other for screwing or some such operation that requires his constant attention.

How badly some piece prices are fixed may be gathered from an instance I came across not long ago. A turner had gone from one large engineering works to another, both doing the same class of work.

At the first he made on piece double the money he made on time at the other; the time he did the work in was the same in both cases, and the machines were also practically the same. There is no doubt he could have done the work in far less time, and would have done so, when working on piece, had he not known that if he made more than double pay his price would have been reduced.

There are many employers who would say that a rise of a matter of sixpence or a shilling a week to the workman would mean ruination to their business. I think that some of these masters might save, not sixpence or a shilling, but six shillings or more a week on each workman they employed, if they could see the advisability of thoroughly organising some system which would encourage the men to work their hardest, and with a keener interest in their work than is given by the ordinary time wages. Much can be done, even when paying time wages, by selecting a few of the best workers, and giving them a slight present of money as a reward for special attention to their work. I believe that such a gift made to a workman, unasked for, gives far more satisfaction than an equal increase of pay if the man has had to ask for it.

To work piece-price or premium systems advantageously, it is obviously necessary to secure the cordial co-operation of the workmen. Many trade unions have resisted the working of piece price on the ground that it is used to make men work harder and harder, the piece rates being reduced as they earn more, until at last the men can only earn the usual day's wage by working harder than is consistent with health. Some of the leaders say that they would not object to piece work, provided the man is guaranteed his time wages as a minimum. To this many employers object, as they think the man might idle his time; but it is difficult to see how this could be worse than if the man were on time work, which would be the alternative if he and his employer could not agree to a piece price. It will be noticed that the premium system described above obviates this difficulty entirely. I will say in conclusion that piece-price systems should not be looked upon as a method of driving down prices by excessively hard work on the part of the workman, but rather as a means of encouraging every workman to do his best and to take greater interest in his work, and of attracting and rewarding a superior class of workman, and by this means effecting a great saving to the employer.

ARBITRATION OF LABOUR QUESTIONS NECESSARY TO INDUSTRIAL ASCENDANCY.

By Charles Buxton Going.



WILL it pay? Bald and sordid as the question may sound, it is the vital one for the advocate of arbitration to answer. Men are gaining a broader comprehension of what is implied by "paying"—are learning to look beyond the shop door and the end of the working day—to see that a man's labour is a physical expression of his life, and will never reach its possible maximum of efficiency until his body and mind are made and kept as efficient as possible. Advanced manufacturers generally are adopting a "humanitarian" policy which they would have rejected contemptuously very few years ago, and everywhere is apparent a growing appreciation of the necessity of acknowledging the ethical method as well as the cosmic in the government of industrial works; but this is simply because of the clearer vision which has been granted to, or forced upon, the world as to what really does "pay." The specifications are the same; the methods of testing only are different. The only demonstration needed to advance the cause of arbitration, then, is that, tried by the widely-comprehensive tests which the economic world has learned to accept, "it pays"—that, in the large, it increases the economy of production.

It is hardly more than a truism to say that the pursuit of economy is the controlling motive in modern life—at least on the material side. Economy is the quickening power in every movement of mechanical progress or industrial advance; it is the determining principle in the final ruling upon every case brought to the test in the progressive adjudication of social and industrial problems. Does this system, or that appliance, tend to cheapen production and to better the product? Then manufacturers may demur and labour may oppose, but the new

The accompanying paper is based almost entirely upon one presented by Mr. Going at the recent Chicago conference of the National Civic Federation for the discussion of Industrial Arbitration. The speakers there argued most fully the political and sociological aspects of arbitration. It is by its economic value, however, that it seems likely to win its way most rapidly in industrial life. With a view of advancing the appreciation of the essential economy of peace in the working world the paper is reproduced here, somewhat revised and expanded.—THE EDITORS.

practice will steadily dispossess the old, and in the end triumphantly prove its fitness by bringing in its train better things than it drives before it. This has been proved over and over again, and never more strikingly than within the century just closing. Methods of dealing with almost every phase of productive activity and contributory function have been revolutionised, all in the interests of greater economy. The whole history of the introduction of machinery, of its constant betterment, of its ever-spreading application, of its continual creation of widening fields for swarming armies of workers, is one great embodied sermon on the same text. Prevention of waste, reduction of friction, taking up of lost motion, averting of stoppage, concentration upon actually useful work, the production of more results and better results from less effort—these are the controlling lines by which the whole structure of modern industry is shaped.

It is needless, except by way of analogy, to recall the bitter opposition of short-sighted economists to every step of this progress. Sometimes vested interests and sometimes labouring classes have been marshalled in desperate resistance to apparently impending destruction, and have called upon society to save itself from crashing down in the ruin which would surely follow the attempt to replace so essential a part of its own structure. It cannot be pretended that individual hardship did not occur: but in the main the new institutions were largely modelled from the materials of the old, the benefits were immeasurably greater than the pains, and it soon became apparent that any sufferings caused by the changes were trifling, compared with those which would have followed the attempt to maintain an old system no longer adequate to the needs of the world. And so, ever justifying itself by its results, the progress of intensification in production has gone steadily on in the mechanical world, striving ever for the ideal of continuous operation at the maximum of economy, and finding, as it comes nearer to this ideal, continually rising gains for all—for the manufacturer, whose plant produces more units of profit-bringing product against a fixed amount of maintenance charges; for the operative, whose wage rises in proportion to his increased productivity; for the consumer, who buys more and more cheaply as competition between sellers forces prices down, parallel with the falling cost of manufacturing.

All this is familiar—almost hackneyed. It is summarised here only because it pictures most visibly the economic conditions of the times by which must be tested every matter offered for incorporation in the industrial system. Will arbitration increase the economy of

production—will it operate to prevent waste, to reduce friction, to take up lost motion, to avert stoppage, to concentrate effort upon useful work, to produce more results and better results from less total effort—in short, will it tend to yield the maximum of serviceable product with the maximum of satisfaction from the minimum of expenditure?

Can there be any answer to this but an emphatic "Yes?" Can there be any feeling but condemnation mixed with wonder toward a system which, in its present stage, spends exhaustive study in saving a fraction of a pound of coal burned under the boiler, and wastes unmeasured human energy wrangling with the fireman while the costly plant stands idle? Which spends unlimited money and brain power perfecting machines that can run continuously without stoppage for re-adjustment, and then tolerates weeks of inactivity while struggling over an adjustment with the machine tenders? Which "scraps" unhesitatingly tens of thousands in money's worth of transmission machinery in favour of a newer type giving a higher percentage of efficiency, and tolerates the wastage of hundreds of thousands in strikes and lockouts, brought on by clinging to an antiquated system for transmitting an understanding between employer and employees, which system has about as low an efficiency as possible? Would any sane Board of Managers attempt to run a railway, or start an electric-lighting plant, or operate a mill or factory, or send a liner to sea, with a mechanical equipment which was certain to break down periodically and lie in inevitable idleness until repairs could be patched up? And yet that is almost an absolute analogy to the status of labour conditions throughout nearly the whole range of such enterprises.

The explanation—at least a large part of the explanation—lies in the fact that progress has been too rapid to be symmetrical, and not unnaturally attention was directed first to those things which could easily be seen, felt, weighed. The physical elements of the manufacturing and transportation system have almost engrossed attention—the less material ones have received comparatively little systematic study. In fact, there has been a certain tacit acceptance of the idea that they were uncontrollable, and that salvation in the struggle for supremacy in industry was to be found through making the machine so perfect that its economy would offset the unavoidable losses from time to time caused by the unruliness and irregularity of the man. It is only lately, and still very imperfectly, recognised that there must be a fitting of methods of management to methods of manufacturing

—that upon the organisation of a great work of any kind even more than upon its equipment, depend its success or failure. The idea is spreading slowly; its apostles as yet are few, and their preaching is not always heeded. But the mechanical triumphs of to-day were won against equal skepticism. But a few decades ago it was "demonstrated" that no steamer could ever cross the Atlantic, because her engines would need more coal than she could carry. But a few years ago faith in the reliability of steam propulsion was still so weak that sails were retained. Electric light and power have hardly yet shaken off the suspicion of being incomprehensible, unreliable, and possible of ill repute. "Machine-made" has not quite lived down a suggestion of reproach. But the steamship and the dynamo and the machine won their way because they performed certain functions better, more cheaply, and in the end far more reliably, than the agencies they displaced. And so will a rational system of adjusting relations between employer and employee win its way against the wasteful, discordant, racking and wrecking methods now generally followed. The world is being rapidly aroused to an appreciation of the hideous wastefulness of war. The cost of it is creating a sentiment which the inhumanity of it never succeeded in making potent. South Africa and the Philippines, it is safe to say, are doing more to discourage war than all the disarmament advocates of the day, with the Hague conference thrown in.

But if war is being discredited politically, it is far more so industrially. We do not need to look far for an object lesson. England furnishes an example, full of meaning, of the mutual disaster to manufacturers and workmen which comes from the fight-to-a-finish method of adjusting labour troubles. It was perhaps the first instance large enough in proportions and clear-cut enough in its setting to be easily studied and correctly estimated. Most labour wars have been (broadly speaking) local, and while tolerably accurate figures of their cost have been presented afterwards by statisticians, no graphic representation of the effects was possible; standards of comparison were confused by similar trouble elsewhere in the country; comparisons with other countries were impracticable on account of national differences of conditions. But in England in 1897 the entire engineering trades including practically all the mechanical industries which furnish the bulk of her export manufactures, became involved in a general strike and lock-out, which was fought to its finish in January, 1898. The scale of operations was national; the measure of consequences, owing to the late rapid extension of competition in

engineering work, was international. Labour and capital were both more thoroughly organised than ever before. The struggle was comparatively free from local violence, destruction of property, or direct physical loss. The "treaty of peace" seems to possess the elements of justice and common sense. Under it, according to an eminent British authority, work has since proceeded, "with very great freedom from disputes compared to any other period when there was an equal demand for labour."* This seems to be a result worth fighting for. What then is the "object lesson"—what was the loss which should discourage any future appeal to force in settling labour questions?

Simply this: that in that year of stubborn idleness England lost trade which she is likely never to regain; that since then, and largely because of the foothold in English markets gained during that time, the United States have passed England in the race for first place as an exporting country—a place which England had held so secure and by so long a lead that she considered it was "England first, the rest of the world nowhere." The price she paid for an archaic method of settling industrial disturbances was an apparently permanent reduction in the volume of her vitally-important export trade.

This is a matter which comes closely home to every one of the great industrial nations. A very great proportion of the present general prosperity, especially in the iron and steel trades, machine-tool trades, and metal-working industries generally, is due to success in securing orders in foreign countries. Gains in this direction are won in international competition largely by high adaptations of mechanical equipment and works organisation, and by the adoption of policies which secure the fullest possible accord and co-operation between employers and workmen in advancing economy of production. The United States had long concentrated their study upon these subjects, but the determining impulse to their industrial expansion was given when England, the long-recognised workshop of the world, stood idle and helpless to fill the orders of her patrons because her entire industrial machinery was stalled and deadlocked, trying to smash to pieces an obstruction, which, with a wiser policy ruling, might have been removed without stoppage. While British masters and men clinched and struggled, their customers went "across the way." And, as I wrote in *THE ENGINEERING MAGAZINE* last May:

"Trade, forced into new channels, is often loath to return to the old

* Sir Benjamin C. Browne, in the Works Management Number of *THE ENGINEERING MAGAZINE*, January, 1901.

ones. America was a permanent gainer by the long protracted British engineering strike. She would be a permanent loser by similar troubles at home. Germany, as a competitor, is keener and more strenuous even than she was two years ago. England, awakened in every part, has been undergoing a reorganisation approaching almost to an industrial revolution. Expansion in the machinery trades, which was won with comparative ease by the United States when the conditions were peculiarly favourable to them, would be hard to hold when the conditions were adverse—harder still, if once it slipped away, to regain from competitors who now blend the best America's mechanical skill has devised with a commercial system she can as yet but faintly parallel."

The land which is to gain or to maintain industrial supremacy must perfect methods of dealing between manufacturers and workmen as she perfects her methods of building bridges and locomotives. The operation of her factories and workshops must proceed as smoothly and continuously, with as little friction or heating or clashing, as do the sewing machines, the planers, the looms, or the engines with which she supplies the four quarters of the globe. She must hold to and extend the resort to reason, justice, and common-sense in the settlement of trade difficulties, so happily exemplified in the agreement reached last May in the United States between the National Metal Trades Association and the International Association of Machinists. She must send the lockout and the strike to the scrap-heap along with the thousands of other inefficient and obsolete devices she has thrown out of her shops. Their wastefulness is intolerable, and should be abhorrent.

The growing movement toward organisation, among employers and workmen both, affords the perfect machinery which should be installed in place of the old disorder. I believe that in the conferences of the leaders of manufacturers' and workmen's associations lies the complete solution of the matter. The overwhelming majority desire only what is fair and just, and in the organisation the few hot heads are harmless against the prevailing reason of their fellows. Most of the difficulties of the past have arisen from partial ignorance, on the part of each side, of the views, the difficulties, and the surrounding conditions of the other. Organisation facilitates association, and association promotes understanding. In this voluntary arbitration, in which the representatives of the co-operating parties—capital and labour, are their own arbitrators, I believe, lies the perfection of harmony and the completion of economy in the industrial world.

It was not by any elaborately devised arbitration board nor by any scheme of "compulsory arbitration" that final adjustment of the great British strike was reached; it was not through any mediation from without, formal or informal, that the threatened general struggle in the American mechanical trades was averted last spring. The medium of approach to agreement, on each side, was simply organisation sufficient to consolidate the respective sides into working units, coherent enough to insure unity of effort, concentrated enough to be brought together into a single field of mutual action, reaction, and influence. Reason, intelligence, and justice did the rest. Grant that, in the former case, reason did not prevail until force had been tried; it was the appreciation of the reason and not the mere yielding to the force which was apparent in the settlement, and this appreciation should last and not need to be renewed by another schooling so rough. Very probably if it had not been for the great preceding British labour-war, whose lessons were still so fresh, there might have been a national struggle between American engineering employers and workmen last summer. Very probably the English engineering strike was the chief thing which averted an American engineering strike. But so should it avert any similar future disaster, for now both sides of the matter are luminously displayed—the wreck of war, the triumphant success of arbitration.

I do not go so far as to say that it is never necessary to fight. The upholding of a principle may be worth anything it costs. Much of the priceless knowledge we have has been won out of the striving and suffering of battle. Many of the laws which will be recognised in the future adjustment of labour difficulties were proved only at fearful cost in by-gone strikes. But the body of experience now gained should make further contention almost, if not quite, impossible. Breaking tests are necessary to determine the strength of materials—but the engineer does not go on testing every individual structure to destruction. The old adage says: "In time of peace prepare for war." A newer paraphrase might be: "From lessons of war, prepare a stable peace."

EDITORIAL COMMENT

The trend toward socialism in Germany, toward (at least) municipalism in England, and toward paternalism in the United States, is called to mind by an enquiry lately addressed to the editors for an "opinion as to the advisability of cities owning and operating the plants of such local industries as tend to become monopolies." The publications of THE ENGINEERING MAGAZINE upon this subject can have left no manner of doubt of our opinion; but this honest enquiry from an earnest student gives ground for recapitulating it.

* * *

There is, in our view, no conceivable disposition of semi-public works which is so certain to blight progress, to sterilise improvement, to discourage expansion, to dwarf development, and to antagonise economy, as is this same municipal ownership. One need look no farther than to electric traction in England, where it has been kept substantially in the hands of the municipalities, and in America, where it has been developed wholly by private enterprise, to find an all-sufficient object lesson. Not only is the British citizen left without proper urban transport, to his own great discomfort and to the oppression of the proper growth of his city, while the American even of the smallest towns has swift, satisfactory, and cheap travel everywhere about his streets and into the surrounding country. More than this; the British electrical industry, and the steam-engine makers who should profit by it, are so hampered by stagnation and lack of opportunity at home that they are hopelessly handicapped in external competition, and have to give way to American rivals even in home business. These negative results of inaction have probably cost England more than America would lose by the jobbery and robbery which, it is always asserted, would attend

putting quasi-public corporations under city or State ownership in the United States.

* * *

Individual initiative, the incentive of individual reward, freedom to expand as far as economic conditions permit or can be made to permit, freedom to conceive great improvements, to plan great enterprises, and to dare attempt them for an individual prize proportionate to the gain brought to the world; opportunity to rise by virtue of one's talent, and certainty of receiving a due share of reward when one can lead his fellows into knowledge of some great advance in the economy of production—these are the influences under which every great achievement on the material side of civilisation is won. And these are the influences which government, with its inevitable bureaucracy and departmentalism, stifles with deadly certainty. Run over the list of men, now directing great private engineering works, who early left the army, the navy, or the civil service because it held no opportunity adequate to their powers. Conceive, if you can, of a Rockefeller, a Yerkes, a Lord Armstrong, or a Sir William Van Horne attaining his full growth in a government office!

* * *

The fear of monopoly is puerile. No franchise should be granted, of course, without assuring protection of the rights of the people; but immeasurably surer is the protection inherent in conditions of production and consumption. The man who had the genius to conceive the consolidation of the oil business, had the genius to go on with improvement after improvement, ever reducing cost; and he had the genius, too, to know that only by giving the consumer a large share of the advantage of every reduction could his output be marketed. The man whose mind could

grasp and organise a system of city tramways did not rest until electric traction, improved equipment, accelerated service, free exchanges and lowered fares, had made street travel more profitable for its owners to conduct, because cheaper and vastly more comfortable for its patrons to use, and therefore used to its full capacity.

* * *

The great results by which mankind is benefited are the tangible expression of the genius of great men, and the system which does not foster the growth of great men—which does not afford them unlimited scope—will not yield the great results demanded by modern conditions of life. Government ownership and operation of industrial undertakings does not afford this scope, because government is wholly misdirecting its functions in attempting the undertaking. Its only legitimate province, as Mr. Redfield says elsewhere in this number, is “to secure to citizens the right to accumulate property and enjoy the benefits of it.” When it undertakes the actual conduct of industrial operations, it simply induces atrophy of that much of the social body, to the infinite harm of the entire tissue.

We undoubtedly need more *intelligent* government supervision of the vast corporations which exist by license from the public. We need above all, in the interest not only of the people but of protecting the corporations themselves from the conscienceless promoter, the political demagogue, and the pettifogging legislator, that there shall be the fullest publicity in the conduct and the systematic reporting of their business. But we do *not* want, and the healthy growth of the world's functions can not support, the blight of municipalism and State socialism.

* * *

A very interesting example of the working of the protective system has lately been brought to notice—an example which shows, more luminously than any length of argument could do, the speciousness of its supposed benefits and the hopeless partiality of its administration.

Beet-sugar interests have been urging the United States treasury department to abrogate the most-favoured-nation clause in Russo-American agreements, whereby Russian beet-sugar is now admitted at a low rate of duty. This would force it to bear the Dingley rates, which would amount to an effectual exclusion. The infant American beet-sugar industry, of course, is the object of the solicitude of the movers in the matter.

But alas! There is trouble in the nursery. This new baby is putting noses out of joint. Machinery makers cry out in distress that, if the Dingley tariff be enforced against Russia to exclude \$340 000 worth of sugar, Russian retaliation, in the form of a 25 per cent. duty, will promptly crush the present export trade of American manufactures to Russia. This trade amounted to \$10,000,000 in the fiscal year ending June 30, 1899, and is said to have reached nearly that figure in the first ten months of 1900—counting, in the latter estimate, direct shipments only, and not the large indirect trade passing through English and German ports. No wonder that there is sudden and startled appreciation of the fact that protection “comes high.”

And this among United States manufacturers—the very shining examples of devotion to the protective-tariff cult and of the reward which is said to come to its votaries. Can it be, after all, that even avoiding the debated question whether the consumer does or does not pay the tariff—ignoring the discussion as to the effect of generally inflated values throughout a country and their influence for or against stability—there is yet something in these markets of the world well worth having and fully procurable only on a basis of free trading?

The industrial rivals of the United States will hope that the Government may rigidly uphold its time-honoured policy of protection; but the signs of the times are all the other way. Too many American manufacturers have tasted export trade and found it sweet; too many experiences are accumulating to show them that if they are to sell, the world over, without handi-

cap, they must be free to buy the world over without handicap. The scales are falling from their eyes, and they begin to see clearly the beauty of far-off fields which before they ignored. When American manufacturers begin to turn toward freer trade, the days of American high protection are ended.

* * *

The politician who has so carefully cultivated the popular American belief in protection and the horror of free trade has merely taken the cue from what he esteemed his most influential constituency. He will be keen to watch the faces of his supporters and to change his play when he finds—as many evidences are beginning to suggest—that the manufacturers of the United States are modifying their views. They are beginning to see that their prosperity has been caused not so much by protection from foreign competition as by free trade throughout their vast land at home. They are beginning to feel that the free trade which has made Britain so rich and powerful in industry and commerce is an essential to their own industrial expansion. And a few concrete instances, like that afforded in the case cited above, will do more to hasten the change than all the logical demonstrations ever uttered or written.

* * *

The subject of the origin of solar and terrestrial heat is a question which has peculiar interest for the engineer, and although the study of the problem is supposed to belong to the domain of physics and astronomy, yet it is altogether a matter for comment and reference in these pages. Of the various solutions which have been proposed, that of Mr. Cope Whitehouse, well-known on both sides of the Atlantic as a geologist and traveller of extensive experience and observation, demands attention. Mr. Whitehouse, in a recent communication, states his theory to be that the heat of the earth is not received direct from the sun by radiation, but is electrically produced, the source of energy being the earth's rotation. If it be assumed that there are magnetic lines of force ex-

tending between the earth and the sun, the rotation of an irregular body like the earth may be supposed to convert a portion of the energy into heat, and this Mr. Whitehouse maintains, is ample to account for the present temperature of the earth. Although this theory was made public in various ways several years ago, it has only found partial acceptance in scientific circles, and that by the reference to some of its features as possibilities. The recent position of Lord Kelvin that the interplanetary medium is not necessarily extremely tenuous, but may be rigid, is altogether in keeping with the theory of Mr. Whitehouse. Observations upon the diminution of temperature with elevation, show that the rate of diminution appears to be a function of the surface temperature, and this, together with the moderate temperatures of elevated plateaus, as compared with the much lower temperatures of isolated peaks of the same altitude, falls in well with the theories of Mr. Whitehouse. The whole subject is one of immense interest for the engineer, and it is more than probable that the full solution of the problem will be made along lines of thought which have been developed in engineering practice rather than in the observatory or physical laboratory.

* * *

In view of the possible or even probable development of the Pacific coast of the United States, it is of interest to note a very frequent misconception as to the relative latitude of the northern Pacific ports. Puget Sound, upon which are situated Seattle, Bremerton, Tacoma, and Vancouver, is generally considered to be well to the northward, and the casual individual naturally assumes this important body of water to be something comparable to the Baltic for example, or to the fiords of Norway.

As a matter of fact, as a glance at the map alone is needed to show, the latitude of Puget Sound is about $47\frac{1}{2}$ degrees, or about two hundred miles further south than Land's End, the southern point of Great Britain, and more than five hundred miles further south than Glasgow. The

great capitals of Europe, London, Paris, Berlin, Brussels, Munich, are all further north than Seattle, which itself is hardly 120 miles further north than Venice.

The prevalence of a similar misconception as to the latitude of American cities on the Atlantic coast has only of late been dispelled, and it is fairly well realised at the present time that New York is on about the same latitude as Naples, and that London is as far to the north as is Labrador. With the development of the resources of the Pacific coast, the misconceptions now so prevalent will doubtless follow those which formerly prevailed with regard to other portions of America, and it is even now none too soon to call attention to facts which, if overlooked, might seriously affect enterprises of development and industry.

* * *

The beginning of a new century has brought forth a vast amount of matter, retrospective in nature and form, much of it sentimental to the point of gush, and all of it of little more than passing interest. Such collections of recent history serve their passing purpose, and are then forgotten, as their form is necessarily ephemeral.

A far more permanent and useful record of the work which has made the end of the nineteenth century noteworthy, the work of the engineer, the applied scientist *par excellence*, is found in the columns of the Engineering Index, the continuous record of engineering development, as recorded in the pages of current technical literature.

It is related that King George III. once made the remark: "I have had occasion to consult the best lawyers in my dominions, and the ablest of them can do no more than refer!" He might well have said the same of a wider subject than the law, and what would have been true at the close of the eighteenth century is a thousand-fold truer at the close of the nineteenth.

The Engineering Index enables the engineer to refer, with a fullness and promptness which without its aid would be impossible; for no matter how fully a

professional man may know his standard works of reference, it is a physical impossibility for him to keep in touch with the latest and fullest form of professional information, the current technical periodical press, except through the medium of such a record. With the completion of the third volume of the Index, now in course of active preparation, there will be placed in the hands of the engineer a retrospect of the work of the closing years of the century, which, unlike others to which reference has been made, will be of permanent value and usefulness, alike a record of the past and guide for the future.

* * *

One of the interesting features of the invasion of the markets of the world by German and American machine tools is the gradual breaking down of national characteristics in machine design. Formerly it was possible, and even easy, for the trained eye of the engineer to distinguish the nativity, so to speak, of a lathe, planer, or engine, not merely from positive details of construction, but mainly because of the general style of design.

Now, however, we are beginning to realise the advent of the cosmopolitan machine. American tools are no longer necessarily made in America, nor are all the British marine engines built on the Clyde or on the Tyne. American tools are beginning to partake of some of the English massiveness, while British machinery is losing some of its anvil-like solidity. The cab for the engine driver is no longer a characteristic of the American locomotive, nor has that country a monopoly of outside cylinders. In these, and in many other obvious ways, the influence of international competition and contact is apparent, and although the ultra-conservative may deplore the fading of local and national peculiarities, there can be little doubt that the whole result is for the decided advancement of engineering practice and commercial development. Let each take the best from all the others, and let the advent of the cosmopolitan machine tool be as welcome as that of all other friendly international relations.



REVIEW OF THE BRITISH PRESS

The Treatment of London Sewage.

EVERYTHING which relates to the health and comfort of a great city is of such surpassing importance, both to the residents themselves and to the world at large, that the paper of Professor Frank Clowes upon the treatment of London sewage, recently read before the Society of Arts, and published in the *Journal* of the Society, demands extended review and abstract.

The population of London, exceeding 5,000,000, and forming at least one-eighth that of the United Kingdom, discharges the whole of its sewage into the river Thames within a short portion of its length, and since the river is the busiest waterway in the world, with a yearly tonnage of more than 23,000,000, the question of the prevention of a colossal nuisance is imperative.

At first the raw sewage was permitted to be discharged directly into the river in the neighborhood of the city, with the inevitable result that the heavier road detritus settled and tended to reduce the depth, while the putrescible matter floated, and, under tidal action, accumulated as a deposit on the foreshores.

In order to reduce these offenses the delivery was removed to a point about fifteen miles below London, and, after this was found insufficient, the sewage was subjected to chemical treatment and sedimentation before it was allowed to flow into the river. The treatment consisted in straining off the larger solid matters, and then mixing the sewage with solutions of lime and sulphate of iron; the chemical precipitate was then allowed to settle by sending the sewage on its way to the river slowly through parallel channels. The screenings were disposed of by being dug into the ground; the settled matter of sludge sent in tank steamers to be discharged out at sea beyond the mouth of the river; and the fairly clear effluent discharged into the river in two streams, which jointly deliver more than 200,000,000 gallons every twenty-four hours,

and constitute the most important tributaries of the Thames below London.

This effluent, however, is only clarified sewage, and contains a large amount of putrescible material in invisible solution. As long as putrefactive changes are delayed by low temperatures, and an ample flush of upper river water comes down to dilute the effluent and carry it out to sea, no sensible foulness occurs. In summer time, however, the high temperature hastens putrefactive change, and when the flush of water from the upper river is diminished, evidence of foulness is apparent. This foulness must be expected to increase with the growth of London, and hence the importance of adopting without delay a method of sewage treatment which shall meet the requirements of the increasing population, and also secure a greater degree of purity than is possible with the present system.

The Main Drainage Committee of the County Council has had this matter under consideration since 1893, and a number of reports, based upon the researches of Dr. Dibdin, Professor Clowes, Professor Frankland, and others, have shown that the settled sewage may be purified to a very high degree by encouraging the spontaneous purifying action of the bacteria which are present in the sewage itself. The effluent thus produced, without the intervention of chemicals, remains free from foul putrefaction, and is able to support the life of fish, and is in all respects greatly superior to that produced by the older method of chemical treatment. The minute vegetable organisms, known as bacteria, exist to the average number of 300,000 to the drop of sewage, and only require to be placed under suitable conditions in order to effect the rapid and inoffensive resolution of the putrescible matters of the sewage into harmless and inoffensive products.

The method proposed by Dr. Frankland for enabling the bacterial purification to take place consists in passing the liquid

through coke beds upon which the bacterial formations have been made. The sewage is allowed to flow into large tanks containing fragments of coke about the size of walnuts. When the level reaches the upper surface of the coke bed the flow is stopped, and the liquid allowed to remain in contact with the bacteria coke surface for two or three hours. The effluent is then drawn off, and the coke bed allowed to rest for three to seven hours, when a new charge of sewage is introduced. The introduction of bacteria from the sewage, and the periodical supply of oxygen provided by the aëration periods, maintains the purifying action. In such a purifying tank it is desirable that the raw sewage should first be rough-screened, and subjected to sedimentation, in order to remove as much as possible of the suspended solid matter, which would tend to choke the coke bed. The dissolved matters and the small amount of suspended matter remaining after these preliminary processes are then readily dealt with by the bacteria of the coke-bed, and no choking of the beds occurs. Careful examination of sewage thus treated shows that more than one-half of the dissolved matter of the original sewage has been removed by the bacteria, and that the portion which has been removed is mainly the matter which would have become very rapidly offensive and lead to the de-aëration of the river water if it were allowed to pass into the river.

"The introduction of such a sewage effluent into the lower Thames is unobjectionable. The river water at the points where the effluent is discharged is uniformly muddy; it is always brackish and frequently salt to taste, owing to the presence of tidal sea water. It is, therefore, not capable of being used for drinking purposes. The effluent would certainly cause no deposit upon the river bed, and would ordinarily tend to render the muddy water more clear by mixing with it. No offensive smell would be emitted by the effluent, as it is discharged into the river. And, although the effluent contains more organic matter than the river water does, the bacteria which it contains would slowly and inoffensively remove this organic matter from the effluent after it has been introduced into the river. The effluent would be suitable for the maintenance of healthy fish life."

Electrical Locomotives and Multiple Driving.

IN considering the application of electric traction to main line railways, the question of the manner of applying the power is sure to attract attention. Everyone is so accustomed to the steam locomotive that at first it seems a matter of course that if it is to be superseded it will be by some other kind of a locomotive, and hence the electrical locomotive has been assumed to be the coming machine. This view has been strengthened by the fact that the limited use to which electric traction has thus far been applied in main-line service has been for tunnel hauling, or similar special work, where a temporary substitute only was required for the steam locomotive, and where electric locomotives necessarily have been used.

The experience of tramway service, however, has shown the capabilities of independent axle driving, and the fact that electrical engineers, well versed in heavy tramway practice, have advocated the application of improved modifications of this system for main line service, brings the two methods directly into the field for discussion.

A recent paper by Mr. Edward H. Tyler, published in *Engineering*, advocates the electric locomotive, and brings forward some excellent arguments in its favour. Mr. Tyler examines the subject entirely on its merits, and states the subject in the following classification:

"1. The problem of applying sufficient power to heavy trains with high acceleration.

"2. The question of economy, by reducing the total weight of train and locomotive.

"3. The subdivision of trains into self-propelling units.

"4. The possibility of being able to control the trains from either end.

"That these factors will vary in relative importance, according to the circumstances of the railway to which they apply, is obvious. There are, besides the above-mentioned factors, general considerations depending on convenience rather than on essentials; and as these will vary in every case, it seems clear that a decision as to the best system to adopt can only be arrived

ed at after an examination of all the circumstances. The alternative methods of electric haulage may be classed as follows:

"1. By locomotives.

"2. By motor-coaches at each end of the train, the leading motor-coach hauling the train, and the end coach trailing, or both ends working.

"3. By independently driven axles throughout the train, controllable from either end only.

"4. By independently driven axles throughout the train, each unit having its own controllers, which are actuated from master-controllers from either end of the train.

"So far, the locomotive system holds the field in almost every case where electric train haulage has taken the place of steam. That is to say, for trains of 100 tons and upwards. It is only fair to say that the system has been rather imposed than chosen. The feature of railways, as distinct from tramways, is that each company is merged in one vast network of lines, over which neighbouring companies run their rolling stock, without regard to the limits of their own systems. It follows that, pending the universal adoption of electric traction, which is not even in sight, the service will be a mixed one, and it will be necessary to handle the ordinary rolling stock of any company possessing running powers. The only means of applying electric traction to this influx of through trains is by electric locomotives. The electric locomotive, therefore, has its reason for existence, and in spite of the competition of other more loudly-voiced methods, it is not likely to be superseded for many years."

There are disadvantages, however, in the application of the locomotive system to heavy electric traction, as Mr. Tyler points out.

"The weak point of the electric locomotive is rather its limitations in the direction of tractive effort than as being an unnecessary weight. It has been generally assumed that, as regards application of power to the wheels, the electric locomotive is easily ahead of its steam brother. As a matter of fact, the restrictions of space and the limitations of the permissible voltage of the current, place the electric locomotive, if comparison is made, somewhat at a disad-

vantage. The space available on any one axle of the locomotive is strictly limited. If geared motors are employed, the gearing takes away so much of the space along the axle. The clearance from the height of the rail limits the dimension as to diameter, and no considerable relief is to be obtained by increasing the diameter of the driving wheels, since by doing so the gear ratio is affected unfavourably."

If the electric locomotive is not to be used, the separately driven axle system must be considered, and this may be either a mere collection of motors, distributed uniformly throughout the train, controlled as a whole from either end of the train; or, it may be the "multiple-unit" system, which consists of a train composed of independently equipped coaches, which, being coupled up mechanically and electrically, form a train having the same tractive characteristics as any one coach.

The conception is a bold one, and the embodiment of it is, perhaps, the most wonderfully and perfectly complex mechanical organism that the ingenuity of man has ever produced. Its scope, plainly, is in the field of electric tramways, where single motor cars, converging on to some main artery of traffic, are coupled together, and despatched at a high speed on a suburban line, which is, to all intents and purposes, a high-speed railway.

The characteristic of the system is not the availability of passenger weight for adhesion purposes, nor yet the subdivision of power for the purpose of space. These are its attributes. But the distinctive feature of the system is its capacity to form, and then disperse. Where this feature is desirable, the multiple unit system offers such inducements that its adoption is only a question of time.

For suburban railway service, such as we now know it—namely, for long trains starting from terminal stations with their full complement of passengers—the question of breaking up of trains does not come in. It is conceivable that it might be desirable in some cases, but in the great majority of cases the long close-coupled made-up trains are the only arrangement that can cope with heavy traffic. If the trains are not to be broken up, there is no object in equipping the train with controllers, master-controll-

ers, and all the necessary air or electrical connections, as the case may be. It is not to be forgotten that all apparatus, and especially apparatus on which the lives of men depend, must be frequently, even daily, overhauled. The fewer units the easier will be the work of inspection and repair. It is, therefore, hardly conceivable that multiple unit control will be adopted for made-up trains, merely because it is a very perfect method of controlling a number of motors. There are simpler methods of controlling a number of motors from either end of a train, which are quite as perfect under the simpler conditions of made-up trains as the multiple unit system.

Mr. Tyler seems to have a leaning toward the electric locomotive, which is, to a certain extent, borne out by his argument, but it seems as if the influence of the precedents of steam practice have much to do with this predilection.

"The conclusions the writer arrives at are, therefore, these: Where the total effort required is not more than can be exerted by a 50-ton locomotive, equipped to haul up to its full limit of adhesion, and where the question of control from either end without shunting is not an essential, the separately driven axle system does not offer any advantages commensurable with its greatly-increased complication. Where the power required is in excess of the above, the alternative lies between multiple-driven axles and coupled locomotives. The general question of convenience would even here seem to pronounce in favour of the coupled locomotive. There is an undoubted advantage in having the equipments separate from the coaches, so that a defective locomotive may be replaced without breaking up a train. If, however, the trains must be controllable from either end, then some kind of multiple-driven axle arrangement is necessary; although if the traffic is frequent enough to make shunting impossible, it should be worth while to end the line in a loop connecting the up and the down rails."

Large Gas Engines for Central Stations.

THE probability that the construction of stations for generating electricity in bulk for commercial distribution will soon be as common a thing in England as it has become elsewhere, renders it desirable that the

choice of motive power for such stations be discussed. For this reason the paper of Mr. H. A. Humphrey, upon the use of power gas and large gas engines for central stations, recently presented before the Institution of Mechanical Engineers, is an acceptable contribution to the study of power generation.

After pointing out the additions to lighting and tramway work now under way or consideration in Great Britain, Mr. Humphrey goes on to show that it is not for these purposes that the real bulk of energy will in the approaching future be required, but rather for manufacturing purposes.

"When electric energy can be generated and distributed at such a cost as to displace the use of steam power plants now operating in manufacturing works, the inauguration of a new era of centralisation in the supply of power will have commenced. The average total cost of a unit of electricity (kilowatt-hour), generated by electric-supply undertakings in Great Britain for 1898 was 2.81d., of which the expense of generation amounted to 1.79d.

"With improved load-factors this figure would be less; but those who know the actual cost of steam power generated on manufacturers' premises will appreciate how much this figure must be lowered, if the manufacturers are to be induced to take electric energy in bulk from outside companies. It is known that several companies will, under certain conditions, supply electric energy for power purposes at 1d. per unit, this being possible because of the higher price paid for lighting current; but even this figure is too high for manufacturers who would require large currents. The approximate cost of power computed under different circumstances shows that, unless the price is reduced to something like ¾d. per unit, only the smaller manufacturers will benefit by the wholesale adoption of current supplied from central stations.

"Where, then, is this cheap supply of electric energy to come from? In Great Britain we have not the Niagara Falls, with their 7,000,000 horse-power, to draw upon, or even the 600,000 horse-power of waterfalls said to be available in Switzerland, and it is certain that we must rely on the coal supply as the only cheap source of power available in really large quantity."

Until recently the gas engine was thought only fit for small powers, and this, together with the high cost of illuminating gas, rendered gas power unimportant for central-station use. With the introduction of cheap fuel gas, and the development of the large gas engine, the situation has been changed. Gas producer plants, such as the Mond, in which the ammonia is recovered as a by-product, and others, have been perfected to the point of full commercial practicability, and the large gas engine is now an accomplished fact.

"The special features of gas engine practice, which have enabled gas engines to be made of powers far beyond those formerly thought possible, may be briefly stated. The most important is the improvement in the design of the cylinder liner, the piston, and the valves, whereby they may all be efficiently water cooled; and probably a time will soon come when no engine of more than 17 inches cylinder will be constructed without a water-cooled piston and a high degree of compression. The better shape given to the clearance space, the disposition of the valves in this space, the introduction of induced and positive systems of scavenging, and the better understanding of the causes of pre-ignition, have all aided in the forward progress of the gas engine, and a noticeable strengthening up of all working parts has taken place. Thus the Westinghouse practice is to make the crankshaft half the diameter of the piston, and in larger sizes even more. For example, with a 34-inch piston the crankshaft is made 9 inches in diameter. Improvements in the breech-end castings, better arrangements for the contraction and expansion of the metal, improved means of ignition, and items of this nature are too numerous to mention, but all help in marking a step-by-step progress in the attainment towards gas engines of great power."

In order to show the extent to which the successful construction of large gas engines has been carried out, Mr. Humphrey gives data of tests of a Crossley engine of 400 h. p., operated with Mond producer gas. The results of this, and other tests, are tabulated very fully in the paper, and only an abstract is given here.

The Mond gas consisted of about 15 per cent. carbon monoxide, 11 per cent. carbon

dioxide, 29 per cent. hydrogen, 2 per cent. methane, and 43 per cent. nitrogen, and a calorific value of about 90 B. T. U. per cubic foot.

At normal load, the engine used 60 cubic feet of this gas per indicated horse-power-hour, this being equivalent to a thermal efficiency of 26.2 per cent.

"It was anticipated that the large Crossley engine would give fully 30 per cent. thermal efficiency; but the makers have kept down the degree of compression to so low a figure that the average effective pressure is only a little above 60 lbs. per square inch. Although this engine has to run at full load day and night, this extreme measure of precaution would be quite unnecessary, if the pistons were water-cooled. However, it is the first engine of its size Messrs. Crossley Brothers have made, and they are to be congratulated on having turned out a workmanlike and successful engine. More economical results are expected from the 500 horse-power 'Premier' gas-engine, which, unfortunately, was not delivered early enough for the tests to be carried out and the results included in the present paper. This engine, when tested at the Premier Company's works at Sandiacre, with Mond gas, showed a mean effective pressure of 103 lbs. per square inch, but there were no means of accurately determining the gas consumption. It is expected that 650 horse-power will readily be obtained from this engine, which is now one of the largest two-cylinder engines in existence."

The crucial question in the problem is the net cost of the current per unit as compared with plants using steam power. Mr. Humphrey's estimates on this point are based upon experience with the Mond gas plant at Winnington, where 150 to 230 tons of fuel are gasified per day. Assuming a central station gas engine plant of 20,000 horse-power, the details of cost are worked out for various prices of slack, and for load factors ranging from normal to 33 1-3 per cent., with the result that the total cost in pence per kilowatt-hour at normal load ranges from 0.082d., with slack at 3s. per ton, to 0.166d., with slack at 10s., these figures including no charges on capital account, rent, rates, or taxes.

Mr. Humphrey's paper gives much valu-

able information concerning trials with other gas engines, including Westinghouse, Delamare-Deboutteville-Cockerill, Oechelhaüser, Otto, and others, and forms a valuable contribution to one of the most important present subjects in the domain of mechanical engineering.

The Manufacture of Iron.

In his presidential address, delivered before the Institution of Junior Engineers, Sir I. Lowthian Bell gives some interesting comments upon the development of the manufacture of iron, from the crude beginnings of earliest times down to the present. The distinguished part which he himself has borne in the development of the iron manufacture gives especial weight to the utterances of Sir Lowthian Bell, and abstracts from his address are of interest.

After treating of the probable conditions under which iron ores were formed, Sir Lowthian Bell referred to the early bloomeries, identical, doubtless, with the methods of prehistoric ages, remains of which have come down to us, and similar to those used by tribes in the interior of Africa when first visited by civilised men. The introduction of coal for charcoal by Abraham Darby, in 1735, made the earlier blast furnace free from the difficulties involved in the use of charcoal, and the invention of the hot blast by Neilson, in 1828, was the next great improvement. While fully appreciating the value of the hot blast in reducing the cost of pig iron, Sir Lowthian Bell affirms that the chief loss of fuel in the cold blast furnace was really due to its lack of capacity, by which an enormous waste of heat resulted from the high temperature of the escaping gases.

About 1850 there were few blast furnaces exceeding 50 feet in height, with a capacity of about 6,000 cubic feet; the weekly production of such furnaces being about 150 tons, with a consumption of about 40 cwt. of coke per ton of metal, with a blast at about 600° F.

About ten years later Mr. John Vaughan erected a furnace a little more than 60 feet in height, and found in it a notable economy of fuel. After examining this furnace Sir Lowthian Bell designed one of 80 feet in height, and a study of this furnace, supplemented by laboratory investigations,

showed a number of interesting conclusions.

It was found that the saving in fuel corresponded to the exact amount of heat brought in by the blast; that the action of that part of the furnace within 8 to 10 feet of the tuyeres was confined to intercepting the vast quantities of heat generated at or close to the tuyeres; that when the reduction of the iron has proceeded to an extent which ends in one equivalent of carbon escaping as carbonic acid to two of carbonic oxide, further power of reduction ceases; and that no increase in height above 80 feet would be attended with any economy, the effect of such addition being merely to raise the zone of production.

After referring to the work of Henry Cort, in the introduction of the puddling furnace, in 1784, the work of Bessemer, and the development of the Bessemer process, was discussed at length. Sir Lowthian Bell admitted that he himself was incredulous as to the possibility of the production of malleable iron in the Bessemer converter, and it required absolute demonstration to convince him of the truth. The account of the aid which the discovery of Mushet as to the use of spiegeleisen rendered in connection with the Bessemer process is of much interest, and confirms statements from other sources as to that portion of the development of the process. Perhaps the most interesting portion of the address is that which relates to the present and future competition between Great Britain and the United States in the production of iron. Comparing Middlesbrough and Pittsburg as characteristic centers of iron production on both sides of the Atlantic, it appears that in America about one-half the amount of raw material is required for the production of a ton of pig iron that is necessary in England. In America, however, the distances over which the material has to be transported to the furnaces, combined with the distance of Pittsburg from the points to which the product must be carried to compete with British iron, renders final the cost of the minerals, mining and carriage included, which are consumed for each ton of pig iron at Pittsburg and Middlesbrough, respectively, almost identical in the two localities.

Sir Lowthian Bell, however, admits that

he has not been in America himself since 1890, and during the past decade the improvements in machinery for transporting and handling minerals, particularly in the iron trade, have effected transformations hardly intelligible to those who have not had the opportunity of examining them. There is no doubt that the productive capacity of the United States, so far as concerns pig iron and its products, such as rails, structural material, etc., far exceeds its own normal consumption, and under these circumstances the invasion of British markets is inevitable, and the problem will settle itself according to the inexorable laws of supply and demand.

The Distillation of Water for Ice-making.

IN the manufacture of artificial ice it is especially desirable that the water should be pure and free from air, as otherwise the ice is cloudy and unattractive both in appearance and quality. Clear ice can be produced from water in its natural state if the supply is pure, by the use of special agitating appliances to expel the air during freezing, but the preferable method is to distill the water, as it is then pure beyond question and also free from air. The principal difficulty is regard to distillation of water is the cost, but this may be kept within reasonable limits by the use of improved apparatus, and hence the paper of Mr. Ral Williams, presented before the Cold Storage and Ice Association, and printed in *The Engineer*, is worthy of comment.

The most usual arrangement is one in which the exhaust steam from the engines is condensed and purified, live steam being added to make up any deficiency. In such apparatus the steam is passed through a scrubber, to remove most of the oil and other impurities, after which it is condensed in a surface condenser, and the condensed water is then reboiled in a separate vessel by means of a steam coil. In this latter operation the air is driven off, and grease and other solid matter is skimmed off, after which the water is cooled, filtered, and stored for use. By this method the cleanliness of the water is dependent upon the re-boiling, and there is often a taste of oil left in the ice, and the method is not the most economical, since no use is made of the latent heat in the steam.

The most economical method, as Mr. Williams points out, is to employ multiple-effect evaporators, such as have long been used to great advantage in the manufacture of sugar. In the triple-effect evaporator, for instance, exhaust steam is passed through tubes surrounded by water, and the vapour thus produced is passed through similar tubes in a second evaporator, and the vapour in this again through a third evaporator. The final vapour is drawn off into a condenser and removed by an air pump, so that there is a progressive vacuum in each evaporator. The condensed steam from the first effect is returned to the boiler as feed, while that from the second and third and the condenser is filtered and used for freezing. In this way the latent heat given up by the vapour in condensing is utilised to evaporate more water, and a high degree of economy is attained. Combinations as high as sextuple effect, on this principle, have been employed; with a triple effect one pound of steam will produce $2\frac{1}{2}$ pounds of distilled water, and a sextuple effect will produce $4\frac{1}{2}$ pounds of water from one pound of steam. It is, of course, desirable to operate an evaporating apparatus with the exhaust steam from the engines, but this involves a certain amount of back pressure, which is sometimes objectionable. Live-steam effects are therefore sometimes employed, although they cannot compete in economy with exhaust-steam apparatus, but are applicable in cases where only a small portion of the ice produced is made from distilled water, as then the main engines can be worked condensing, and a corresponding economy secured.

Mr. Williams describes several varieties of evaporating apparatus, including sextuple-effect devices to be used with live steam, and employing the so-called "film principle" of evaporation, by which excellent results have been obtained.

The paper concludes with a comparison of the cost of distillation of water by four different methods, the first being by the direct condensation of the exhaust steam from the engines, and first described above; the second the triple-effect, using exhaust steam; third, the triple-effect using live steam, and, fourth, the sextuple-effect, the computations being reduced to the same basis in all cases.

Comparing the cost in coal of distilling 50 tons of water in each case the relative values, taking coal at 10s. per ton, are:

	£	s.	d.
No. 1 plant costs in coal per 24 hours	3	2	6
No. 2 plant costs in coal per 24 hours	2	4	0
No. 3 plant costs in coal per 24 hours	2	18	0
No. 4 plant costs in coal per 24 hours	2	8	0

The superior economy of the second apparatus is due to the combination of triple effect with exhaust steam, while the same efficiency is nearly attained in the fourth by the sextuple effect, even though live steam is employed.

Education and Trade.

It is refreshing to find in a recent editorial in *The Engineer* a very sensible view of the relation of technical education to commercial supremacy. It has been dinned into the ears of the British public from many quarters that it is the superior technical training which has enabled Germany and America to enter England's markets; and the necessity of providing some form of education which shall provide the antidote, is a frequent cry.

At the same time concrete examples of the actual effect of the German or American educational methods upon commerce and manufacturers are decidedly lacking. The introduction of aniline dyes is quoted as an example of what scientific research has done for German trade, but after this is quoted there is a hesitation and doubt as to what else to name.

With regard to American competition, there are doubtless some excellent American machines, tools, etc., in the market, but it has yet to be shown that these are anything but the results of the experience of American mechanics, rather than directly due to any especial scientific training. It is rather urged that American success is due to general intelligence, but it has yet to be shown that this is specifically true, and indeed all statements of the sort are vague generalities.

The great mistake made by critics of British trade is that of comparing it with America and Germany of a few years ago. For England to have maintained her relative

position of a short time ago it would have been necessary for her trade to have increased in a far greater proportion than that of the rival countries. If British trade was double that of America twenty years ago, and America's trade has increased twenty fold since then, British trade would have had to increase forty fold to preserve the same relative position. On the contrary, if the lead only was to be maintained, there would need to be only a small actual difference. It is not to be expected that a comparatively old country should maintain the same rate of progress as that of a far younger country with unlimited possibilities and a limitless area. The real question is not whether America and Germany are improving their markets, but whether England is improving hers. To assure this several things must be done.

"Improvement of the artisan will help, technical education will help, but more than anything success will depend upon commercial astuteness. It is that, and that almost entirely, which has given America and Germany their success in late years. Their goods are not better than British goods, but they know how to sell them; their knowledge is no greater, but they use it more wisely. What should be established are more schools of commercial training—schools where the art of selling will be taught and the art of organisation will be a feature of the curriculum. It will be useless to be provided with splendid methods, with clever workmen and excellent tools, if with these are not provided the means to induce the markets to accept the goods.

With this increased commercial intelligence must come also increased knowledge of modern methods of works management. Astuteness must come not only at the selling end, but also at the manufacturing end. It will not do to have the best products if they cost more than they can be sold for, and the goods must be reduced in cost without reduction in quality. Here the manufacturing skill must come in, and by repetitive process, automatic machinery, systematised methods, and accurate shop accounting and cost-keeping, the product may be made with British thoroughness combined with American ingenuity and German skill, and it can then be sold in any market in the world, in competition with any rivalry.



REVIEW OF THE CONTINENTAL PRESS

The Electrical Equipment of Modern Warships.

THE general introduction of electricity in nearly every branch of industry during the past decade is well known, and one of the most striking examples of its importance is found in marine, and especially in naval service. For this reason a paper upon the electrical equipment of modern warships, recently presented before the Society of German Electrotechnologists at Kiel, by Naval Constructor Grauert, and published in the *Elektrotechnische Zeitschrift*, is of much interest.

The progress which has been made in the use of electricity on shipboard is seen when it is observed that the first use of current, in the German Navy, being that for electric search lights, was made in 1882, and that the first German cruiser to be fitted with electric lighting was the "Bayern," in 1887. This plant consisted of three dynamos of 33 kilowatt capacity, and included 225 lamps of 10 candle power and a total length of conductors of about 4,500 metres. In addition to the general lighting, there were two search lights taking 70 amperes at 50 volts, and some signaling apparatus. This installation cost about 23,000 marks, not including the search lights.

It is interesting to compare this early plant with that on the "Fürst Bismarck," one of the latest installations in the German Navy. Here the generators have a capacity of 325 kilowatts, operating about 900 lamps, as well as 44 motors aggregating 150 kilowatts, 5 search lights, and numerous signal, telegraph and telephone systems. The wiring makes a total of 33 kilometres, in which the multiple-wire cables for the telegraph and telephone systems are counted as single lengths.

This plant weighed 103.5 tons, of which 40 tons consisted of cables, and exclusive of the 5 search lights, which cost 60,000 marks, the total cost was 220,000 marks. These figures show better than anything else the

progress which has been made in the use of electricity in the navy during the past decade.

This general introduction of electric appliances is due to the many advantages of electric transmission. For power transmission electricity replaces steam, and thus does away with the heat emitted by steam pipes, the electrical conductors also being much lighter, taking up less space, and being more readily installed. There is little trouble in keeping properly protected wires in good order, while the danger in case of damage from shot during battle is much less than is the case with steam pipes, and repairs are more readily made on board.

As already indicated, the first use of electricity on shipboard was for lighting, including both general lamps and search lights, and at first the appliances were very primitive in construction and arrangement. At the present time the arrangement resembles more nearly that of a stationary power station. The lighting itself is divided into a number of kinds, including the signal lights, both fixed and intermittent, these being generally controlled from a special switchboard placed in the conning tower or chart room. The use of electricity for power transmission followed naturally upon that of lighting, and has by no means yet reached its limits. Motors have been found especially convenient for driving ventilators, operating ammunition hoists, coal hoists, and small windlasses. For the heavier windlasses, anchor hoists and steering gear, and for the manipulation of heavy guns, steam or hydraulic power yet retains place. The further use of electric power is partly governed by the intermittent character of most of the work, since the generating plant must be made large enough to meet all the demands which may be made upon it, and this, during action, may include nearly all the motors, while during general service much of the machinery remains idle. An important de-

partment of electrical work on shipboard lies in its use for the transmission of orders, not only for the navigation of the vessel, but also for the action of guns, torpedoes, etc., etc.

The mechanical "telegraphs" used in the merchant marine for communication between the bridge and the engine room are well-known, and consist of two dials fitted with pointers which indicate the directions to be sent, a mechanical communication of light shafting causing the pointer in the engine room to follow the movement of the handle fitted to the dial on the bridge. Electrical devices of similar action have been made, in which electricity acts to replace the connecting mechanism. For the communication of special orders, for which optical signals are unequal, some form of acoustic device is used. Formerly speaking tubes were used for this service, but the increasing length of vessels, and the many bends and angles found necessary, have made these unsatisfactory. The loud-speaking telephone of Siemens & Halske has been found a most satisfactory substitute for the speaking tube, and on the "Fürst Bismarck" there are 57 single and 6 multiple sets of these telephones.

Electric heating and cooking have as yet found but few applications on shipboard, the cost being greatly in excess of steam, and as this latter is always available it will probably continue to be employed.

Herr Grauert gives designs of switchboards used on several of the most recent vessels in the German navy, and examples of the methods of wiring. Among the latter may be mentioned the protected central gangway on the "Kaiser Wilhelm II.," through which all the main cables are run, thus avoiding the usual intricate and inaccessible runs otherwise unavoidable in wiring a vessel.

The Measurement of Steam.

In determining the volume of water delivered in a given time, the well-known methods of measuring the velocity and cross section of the stream may be used, or the method of a weir is employed, while for a permanent gas there are various forms of meters, as well as the method of delivering the gas into a holder of known dimensions. For steam, however, the usual

method of measuring the volume delivered is to deduce it from the measured volume of water evaporated or from the amount of water produced by the condensed discharge. Neither of the latter methods is altogether satisfactory, and hence the discussion of a direct system measuring both the quantity of steam delivered in a given time, and the rate of delivery at any instant, by means of the Gehre steam meter, contained in an article in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure*, by Herr L. C. Wolff, is of interest.

The principle of the Gehre meter is that of the drop in pressure when a flow of steam occurs through a contracted aperture. The simplest means of computing the velocity of flow under these conditions is by what is known as Napier's Law, formulated by Zeuner in his treatise on Technical Thermodynamics. The Zeuner-Napier formula enables the weight of steam discharged per second through a given opening to be found with a very close approximation to accuracy, the computation being facilitated by tables, adapted for differences in pressure ranging from 1-100 to 1-10 of an atmosphere. Within these limits the discharge is practically independent of the absolute pressure, being governed only by the difference in pressure on the two sides of the contraction. By assuming a small difference in pressure the formula is greatly simplified, so that for all practical purposes it is reduced to a matter of simple multiplication.

In order that no arithmetical operations may be necessary, the meter is arranged with a mechanical device by means of which the weight of steam can be determined by the examination of a recorded diagram. The apparatus by which this is accomplished is very ingeniously designed, and for the details reference must be had to the original paper. Since the formula involves variables, which, when graphically plotted, appear in the form of curves, this must be provided for in the instrument, and so properly curved templates are used, which enable the direct rise and fall of gauge pistons, acting in direct proportion to the variations in pressure difference, to record upon a moving sheet the ordinates corresponding to the flow at every moment.

The position of the recording point thus gives the rate of flow at the moment of observation, while the total delivery of steam in any extended period is obtained by measuring the area of the recorder diagram by a planimeter, in a manner similar to an indicator diagram.

The simplicity of the apparatus is remarkable, and the accuracy of its readings has been tested by repeated measurement of volumes of steam which were subsequently condensed and weighed. In the earlier instruments the error sometimes reached 5 per cent., but with the perfected apparatus it is kept below 1 per cent.

The usefulness of such a steam meter will doubtless be appreciated by many engineers. It has been possible to compute with more or less accuracy the amount of steam used by a steam engine from the indicator diagrams, but there are many other important applications in which no such method is possible. Thus in the case of steam heating, cooking, drying, etc., etc., it is often most desirable to be able to measure the quantity of steam, while in engine tests the combination of feed water measurement, indicator diagrams, and steam meter affords a triple check which must add greatly to the reliability of the results. There is little doubt that the advances which have been made in steam economy are largely due to the more accurate knowledge of performance which improved instruments have made possible. The indicator has been followed by the recording gauge, the pyrometer, the gas analysis apparatus, and the calorimeter, and the steam meter is a welcome addition to the list.

The Internal Friction of Lubricants.

LUBRICANTS are generally supposed to act by forming thin layers of a viscous medium between the two surfaces, the rubbing friction of which it is desired to reduce, and there is no doubt that in general this is the action which takes place. The behaviour of the particles of the lubricant, acting upon each other, however, has not been so generally considered, and hence the investigations of Professor Petroff are of interest and value. Professor Petroff's paper, treating of what he calls "intermediate friction," was presented before the Imperial

Academy of Sciences of St. Petersburg, by which it was awarded the Lomonossow prize, and has been published in the *Bulletin* of the Academy.

The variations in the lubricating efficiency of various oils are well-known, and carefully conducted experiments of Professor Petroff confirm the conclusions of other investigators that the value of a lubricant cannot be determined from its density, its temperatures of inflammation and congelation, its transparency, or its general appearance. Under these circumstances it has been sought to determine the causes for these variations in lubricating action, and hence Professor Petroff has made a study of the internal friction of the particles of the film of lubricant upon each other. That such an internal friction exists appears from the fact that when one surface slides upon another the force of friction is more or less completely transferred through the film of lubricant from one surface to the other, and, as the film does not move entirely with either surface, an internal motion of its particles must be produced.

The problem really becomes one of hydrodynamics, and demands the solution of the question of the relation between the two forces of external friction between the rubbing surfaces and the internal friction in the particles of the lubricant. In order to determine the data necessary for the solution of the problem, Professor Petroff has made many experiments, of which he gives the tabulated results in his paper.

The theoretical examination of the problem leads to the rather unexpected conclusion that the internal friction is independent of the velocity of the rubbing surfaces and of the density of the lubricant. The experiments made to verify this theoretical conclusion are given in detail in Professor Petroff's paper, the results of more than 600 experiments being tabulated and plotted as curves, the results not only confirming the theoretical deductions, but also serving to determine the numerical value of constants for a great number of different lubricants. The result of the investigations showed that each lubricant possesses what may be called a characteristic curve, and an examination of these curves enables the relative internal friction to be compared.

The apparatus used in the experiments of Professor Petroff consisted practically of a form of brake, in which the revolving journal was clamped between two boxes, the boxes and clamp forming a sort of pendulum carried upon the journal. When the journal was revolved, the weighted pendulum assumed an angular position, in which the moment of the whole mass opposed the friction of the journal and boxes, this friction being transmitted through the film of lubricant upon the bearing, and measured by the angle of deflection of the pendulum. A recording device enabled this deflection to be indicated upon a travelling strip of paper moved proportionally to the speed of revolution of the journal, devices being provided to enable the temperature of the bearing and of the surrounding air to be taken. A modified form of this apparatus was constructed to receive the standard railway axle and bearings, so that lubricants intended for railway service could be examined under conditions similar to those of actual use.

The above described apparatus gives the total friction, the energy thus absorbed reappearing in heat in a manner which can be conveniently measured. The internal friction in the lubricant is determined separately by means of a device in which the oil is forced, under a known pressure, through a long tube of fine bore, the time required to deliver a given volume of oil through the tube being the measure of its viscosity. The characteristic curve of each lubricant is plotted, using the temperatures as abscissas, and the viscosities as ordinates, and in connection with the records of total friction they render it possible to select the best lubricant for any given service.

The method of investigating lubricants according to this method consists in drawing the characteristic curves of the various oils from which choice may be made. The mean temperature of the surrounding air is then taken, as well as that of the bearing film for any one of the lubricants. The point is then taken on the characteristic curve corresponding to the temperature of the bearing, and also the point on the axis of temperatures corresponding to the temperature of the surrounding air. A straight line is then drawn through these two points, and the ordinates of the inter-

sections of this line, with the characteristic curves, give the relative values of the forces of friction for the respective oils. The cost of the power required to overcome these resistances are proportional to the respective forces, and these may then be compared with the cost of the corresponding lubricants.

The importance of the consideration of the viscosity of lubricants has been discussed before the appearance of the paper of Professor Petroff, but his exhaustive discussion of the whole subject is a most valuable contribution to the literature of power transmission, and is well worthy the examination of engineers who have realised the importance of intelligent lubrication as a means of diminishing friction losses.

The Steam Turbine.

THE report of the tests made at Elberfeld by Messrs. Lindley, Schröter, and Weber, upon the Parsons steam turbine, has already been reviewed at length in these columns (September, 1900,) and this report has now been translated into French, and published in the *Revue de Mécanique*. This translation is followed by a discussion from the pen of M. Rateau, whose ability and experience in this especial branch of work is well known.

M. Rateau calls attention to the high efficiency of the alternator operated by the Parsons turbine, and attributes this to the great peripheral speed of the inductor, which in this case attains 60 metres per second, or about double that usually found. The attainment of this high speed is a direct result of the use of the steam turbine as a motive power, and is an additional argument in favor of the steam turbine, over and above any general advantages which it may have as a motor. Apart from the diminished proportional reaction of the inductor at higher speeds there is also the increased steadiness of rotation due to the fact that the kinetic energy of the revolving member increases with the square of the velocity, while the power increases directly as the speed, so that the fly-wheel action increases with the speed.

The high economy shown by the Parsons turbine tested at Elberfeld bears witness not only to the efficiency of the machine,

but also to the excellence of the vacuum. The steam consumption, at 1,200 kilowatts, of 19.4 pounds per kilowatt-hour, corresponding to about 14.5 pounds per electrical h. p. hour, is equal to that of the best triple-expansion engines, leaving in this respect no reason for preferring the latter machine.

M. Rateau takes the data from the Elberfeld report, and proceeds to compute the theoretical steam consumption corresponding to an efficiency of 100 per cent., and shows that with a load of 1,200 kilowatts the actual efficiency was 58 per cent., a most excellent result. In his report at the recent Congrès de Mécanique, at Paris, M. Rateau showed that it was not difficult to obtain an efficiency of 64 per cent. with the steam turbine, and taking the efficiency of the alternator at 94 per cent., a figure which should undoubtedly be attained, an efficiency of $0.64 \times 0.94 = 0.60$ is secured for the combination, which agrees very closely with that experimentally obtained in the Elberfeld trials.

Recent experiments at the Sautter-Harlé establishment have demonstrated that it is possible to obtain, with steam turbines of 2,500 to 3,000 h. p., an efficiency of 70 per cent. for the turbine alone. The steam consumption, with an admission pressure of 114 pounds per square inch absolute and an exhaust pressure of about 0.9 pounds absolute, and a superheat of 20° C., would then fall to 17.1 pounds per kilowatt-hour, corresponding to 12.75 pounds per electrical h. p. hour, an efficiency which has as yet not been attained by any piston engine.

When it is considered that the whole line along which advance in steam engineering must be made involves high speeds, and electrical transmission and distribution of energy, it certainly appears that the steam turbine must be the coming form of steam motor. Engineers have sought for a successful rotary engine for more than a century, realizing that the inherent defects of the reciprocating engine formed a bar to improvement. All rotary engines, however, possessed far greater defects than the form which they sought to replace, and were especially wasteful of steam. In the steam turbine, however, we have the entire elimination of

reciprocating parts, the predominance of the speed element of power generation, carrying with it reduction in weight and steadiness of motion, and, finally, a steam economy higher than that of any piston engine yet constructed. With these advantages are included the adaptability for direct connection with electrical generators of a most desirable and efficient type, the whole forming an ideal combination for the generation of power from coal and its distribution in the form of electricity. Unless some corresponding improvement is made to enable the reciprocating engine to maintain its present commanding position, it seems reasonable to assume that the steam engine of the future will be of the high-speed, rotary type, based upon some one of the present forms of steam turbine.

The Phase Theory of Iron and Steel.

UNTIL within the past few years the knowledge of the real conditions which exist in the various forms of iron and steel was very vague, and the theories contradictory, but in very recent years the researches of a few scientists have brought some measure of order out of the chaos, and the study of iron and its combinations may fairly be said to have entered upon a new period. The whole period of investigation and research upon which the modern ideas rest is well covered by an important paper translated from the German of Professor H. W. Bakhuis Roozeboom by M. F. Osmond, and published, with full comments, by MM. Osmond and Le Chatelier, in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*.

In 1896, Baron Jüptner von Jonstorff called attention to the necessity for gathering the observed and hitherto contradictory facts into some sort of orderly system, and early in the following year appeared the masterly paper of M. Le Chatelier upon the existing condition of the theories of the tempering of steel. Le Chatelier then enunciated the theory that the alloys of iron and carbon, known as steel, were in reality solid solutions, which during cooling were capable, in a manner similar to liquid solutions, of depositing either simple or compound bodies, or both. Le Chatelier also showed that these trans-

formations were closely connected with the allotropic transformation of the iron itself, a fact which had already been suspected by Osmond. The fourth report of Professor Roberts-Austen to the Alloys Committee of the Institution of Mechanical Engineers appeared about the same time, treating the subject in a similar manner, and gathering the observations in the form of a graphical diagram representing the phenomena of solidification and those of the transformation into a solid mass. This was the first attempt to give a complete view of the relations between iron and carbon.

In 1898 appeared further communications from Baron Jüptner, discussing the "solution theory" of iron and steel, followed by the researches of the author, Professor Bakhuis Roozeboom, the fifth report of Sir Roberts-Austen, and the work of Stansfield. These later researches have furnished data enabling more complete diagrams to be formed, and in discussing these Professor Bakhuis Roozeboom enunciated the so-called "phase theory" as applied especially to the phenomena of solidification.

The very full discussion of Professor Bakhuis Roozeboom takes up the behaviour of mixtures containing various percentages of carbon, showing in each case how the proportion of carbon present affects the behaviour at various temperatures. For the details the reader must be referred to the original paper, but some of the conclusions may be given here, and the practical value of the researches shown.

The general conclusions may be summed up as follows:

Cast alloys containing from 0 to 2 per cent. of carbon, solidify in crystals of a homogeneous mixture in which the iron is in the so-called gamma state, that is, stable above 890° ; this combination being called martensite. Cast alloys containing from 2 to 4.3 per cent. of carbon form, in solidifying, a skeleton of mixed crystals of which the intervals are filled with the eutectic alloy consisting of a conglomerate of mixed crystals and graphite containing 4.3 per cent. of carbon. By the eutectic alloy is meant the alloy which solidifies at the lowest possible temperature for the series under consideration. Cast alloys containing

more than 4.3 per cent. of carbon form, in solidifying, a skeleton of crystals of graphite, of which the interstices are filled with the eutectic alloy.

Alloys containing more than 2 per cent. of carbon deposit their carbon at temperatures between $1,130^{\circ}$ and $1,000^{\circ}$. At $1,000^{\circ}$ there occurs a transformation which produces the carbide of iron known as cementite, at the expense of the martensite and the graphite. When the total carbon content is less than 6.6 per cent. there is thus obtained a conglomerate of martensite and cementite. This transformation is the first example in which a chemical combination (cementite) is formed of a solid solution (martensite), and one of its elements (graphite), and that at a temperature quite comparable with the temperature of the transformation at which combinations are produced in the liquid solution and one of its elements.

The formation of cementite advances progressively between $1,000^{\circ}$ and 690° , the crystals of martensite in the conglomerate being impoverished in carbon down to 0.85 per cent. These crystals disappear altogether at 690° , decomposing into alpha iron, or ferrite (stable below 770°), and cementite.

When the normal order of events is not followed it is due to sudden cooling. The action in this case is difficult to determine, but it appears that cementite is immediately formed, and that, from the instant that cementite is formed from the martensite and the graphite, a portion of the latter escapes entirely the transformation.

Alloys containing from 2 to 0.85 per cent. of carbon may, during the period between $1,000^{\circ}$ and 690° , allow the cementite to separate, and, at 690° , to be decomposed into cementite and ferrite; but these two transformations may be checked by rapid cooling, the mixed crystals then being retained as martensite.

Alloys containing from 0 to 0.35 per cent. of carbon show a gradual separation of beta iron between 890° and 770° , and then, at 770° a total transformation of the beta into alpha iron, followed by a gradual separation of the alpha iron, the mixed crystals remaining at 770° . Alloys containing 0 to 0.85 per cent. of carbon only show a separation of alpha iron between

770° and 690°. In all the alloys from 0 to 0.85 per cent. of carbon, the transformation of the mixed crystals of martensite existing in ferrite and cementite is produced at 690°. The conglomerate of these last two (perlite) contains 0.85 per cent. of carbon. The transformation of the mixed crystals containing from 0 to 0.85 per cent. of carbon like those of the alloys containing from 0.85 to 2 per cent., may be suppressed by a sufficiently rapid cooling from the higher temperature to the point of transformation, this constituting what is commonly known as tempering.

The description of the transformations of the mixed crystals containing from 0 to 0.85 per cent. of carbon may be slightly modified if it is admitted that both the alpha and beta forms of iron are capable of dissolving small quantities of carbon, and this supposition is not contradictory to any observed facts.

The alloy known as austenite, like martensite, may be compared to mixed crystals separating from a concentrated liquid solution, and may exist by the side of martensite and cementite, being transformed by slow cooling into a conglomerate of the two latter.

The comments of MM. Osmond and Le Chatelier upon the exhaustive paper of Professor Roozeboom confirm in nearly every point the correctness of his judgment in the readings drawn from experiment.

The Progress of the Siberian Railway.

IN view of the activity in China of European interests and the influence which is produced thereby upon everything relating to communication with that part of the world, the progress of the trans-Siberian railway is a question of very present interest. Two recent papers before the Société des Ingénieurs Civils de France bear upon this subject; one, by M. Platon Yankowsky, upon the crossing of Lake Baikal, and the other a review, by M. A. Jacquin, of the communication of M. Ziffer to the Austrian Society of Engineers upon the railways of Siberia in general. To these may be added an article by Herr F. Theiss, in a recent issue of *Glaser's Annalen*, upon the Manchurian railway, and the importance of Port Arthur considered as a Russian naval station.

The crossing of Lake Baikal, with which M. Yankowsky deals, is a peculiarly difficult problem, since it involves the transport of trains by ferry, through heavy ice, over a rough body of water for a distance of about 40 miles.

It is ultimately intended to replace this lake crossing by an all rail route around the end of the lake, and two routes have been surveyed for this extension. One of these is about 85 miles long, and the other 190 miles; the longer route, which will probably be adopted, making a circuit to follow the Irkout river, and involving a tunnel more than two miles long, piercing the Zyrkouzoune range. This section of the railway will probably not be completed until 1903, and with the still uncompleted Manchurian section, must be finished before the complete railway across Asia is an accomplished fact. In the meantime the Lake Baikal ferry will continue to be used, and even after the section around the lake is completed the ferry will probably be maintained for some trains, because of the shorter distance.

The necessity for using powerful ice-breaking boats, having a draught of 20 feet of water, required the construction of landing piers extending out into the lake to deep water. The pier connected with the western section of the railway, at the Lake Baikal station, is 1,800 feet in length, and that at Missovaia, on the other side of the lake, is 1,200 feet long. These piers are constructed of wooden caissons, filled with stone, each being made in the form of a fork, with two branches of unequal length. The longer branch of the Y extends out into the lake, and the shorter branch extends along the shore, the ferry boat entering into the protected space between. A special form of hinged bridge enables the varying height of water to be provided for in running the trains upon the ferry boats. Powerful electric lights, forming light-houses of the sixth order, are erected upon the moles in order to guide to the entrance.

The chief interest, however, is centered in the boat "Baikal," a powerful ice breaker, constructed partly upon the plans of the American ice-breaking ferry boats, "St. Marie" and "St. Ignace," used on Lake Michigan, and partly on the model of

Nansen's polar ship, "The Fram." The "Baikal" is 290 feet long, by 57 feet beam amidships, and 26½ feet deep, with a forward draught of 20 feet. The total displacement, including 580 tons of water-ballast and 250 tons of coal, is 4,200 tons. There are three propelling screws, two in the stern and one at the bow, these being driven by three triple expansion engines of 1,250 h. p. each. The two stern propellers enable a speed of 12½ knots to be maintained in smooth water, while the three screws drive the boat easily through solid ice 3½ feet thick at a speed of about 3 knots. The "Baikal," as an icebreaker, is second only in power to the "Ermak," constructed by Vice-Admiral Makaroff for the winter service in the Baltic.

M. Yankowsky's paper gives interesting details about the construction of the piers and connections, as well as data concerning the operation of the ferry service.

The general review of the Siberian railways, by M. Jacquin, is devoted mainly to the trans-Siberian railway, which is treated in its several sections, giving details of character and construction of each portion, and of the population and nature of the territory. There are also given valuable data concerning projected railways, of which the greater number form branches of the main Siberian line.

Including the various branches of the Siberian system, from the western section, starting at Tcheliabinsk, and opened in 1896, to the last portion of the Eastern Railway of China, the Manchurian section of the Siberian railway, to be completed in 1906, the railways of Siberia foot up a total of 7,639 kilometres, or 4,740 miles, at a total cost of 982,116,250 francs, or 128,566 francs per kilometre.

The great effort of Russia, ever since the days of Peter the Great, has been to obtain a naval station in waters open and free from ice the whole year 'round. In Europe both Cronstadt and Archangel are closed in winter, while the outlet of the Black Sea is in the control of other powers. Vladivostock, the original port selected as the terminus for the Siberian railway, is closed for several months in each year, while Port Arthur, situated most advantageously on a peninsula on the Yellow Sea between Corea and the main coast of China, has only a thin sheet

of ice on the inner bay for two or three weeks in winter, and the main roadstead is entirely free from ice at all times. It was to secure this coveted port which led to the negotiations by which the Russian government acquired the privileges of diverting the eastern section of the railway through Manchuria, and although the nominal terminus is still at Vladivostock, the spur of railway, leaving the main line at Hulan and running southward to Port Arthur, is practically a division of the main line, and destined to become most important.

The entrance into the bay of Port Arthur is about ¼ mile wide, and a little more than ½ mile long, the main, or western harbour being separated from the outer roadstead by a hilly peninsula, called, from its form, the "Tiger's Tail." The so-called eastern harbour is really an artificial basin, formed by deepening and enclosing a fresh water lake, and is about 1,600 feet long by 1,000 feet wide, and capable of receiving the largest battle-ships. This basin is about 32 feet in depth, and is enclosed by granite sea-walls, upon which are mounted numerous cranes and electric-lighting standards. The harbour is surrounded with warehouses, machine shops, and other buildings, and there are two docks, one large one for warships, and a smaller one, adapted for torpedo boats, destroyers, etc. On the peninsula, which separates the western harbour from the outer bay, is the location for the torpedo arsenal, and a small drydock for the reception of torpedo-boats. Here are also numerous work-shops, a training school for mechanics, and vaults for the storage of explosives. The town itself, with a population of about 50,000, lies to the north of the western harbour.

The fortifications of Port Arthur, which were originally designed according to the plans of Hannecken, were carried out later by English and French engineers, and these works have since been extended by Russian engineers so thoroughly that the place is now undoubtedly a fortress of the first rank. The fortifications on the hills on the sea side of the town include a number of forts fully equipped with Krupp rapid-fire guns. During the past year the Russian government has spent upon harbour improvements, including docks, workshops, floating cranes, barracks, etc., about 11,000,000 roubles.



REVIEW OF THE AMERICAN PRESS

Transcontinental Triangulation.

THE completion of the geodetical connection between the Atlantic and Pacific coasts of the United States marks an important step in the completion of the measurement of the earth, and an interesting résumé of the work is given by Mr. John E. McGrath, assistant in the U. S. Coast and Geodetic Survey, in a recent issue of *Engineering News*.

The measurement of the Transcontinental Triangulation was directed by Congress by the Act of March 3, 1871, providing "for extending the triangulation of the Coast Survey so as to form a geodetic connection between the Atlantic and Pacific coasts of the United States." At that time the geodetic data available for incorporation in the proposed arc comprised the results from the measurement of the Kent Island base, the angles at 13 stations of the triangulation along the Atlantic Coast, 7 azimuths observed in connection with the same triangulation and 19 latitudes. The completed arc depends upon ten bases; horizontal angle observations at 308 primary and 240 secondary stations; an unbroken line of precise levels from Sandy Hook, New Jersey, to Rock Creek, Wyoming, supplemented by vertical angle measures which complete the hypsometric connection from ocean to ocean; 109 latitude stations, 73 azimuth stations, and observed differences of longitudes at 37 stations.

The measurements of the various bases form a most interesting feature of the work, representing, as they do, a variety of methods and apparatus, and confirming, in a most satisfactory manner, the accuracy of the entire system of triangulation.

The measurements at the Holton and St. Albans bases produced results of great interest to the geodesist and engineer. At Holton, Ind., the Woodward steel bar-in-ice was first used for the measurement of a standard hectometer and kilometer section, and its successful operation proved

that it solved the problem of supplying a practicable form of field apparatus from which the varying temperature effects, the chief source of error in all high-class metrology, were eliminated; here also was put to a satisfactory test a modification of Jaderin's method for the use of metallic tapes for geodetic base work. At St. Albans, West Virginia, is the first base of the triangulation measured exclusively with a steel tape. The standardizing section for securing the length of the tape was 100 meters in length, and was determined with a 5-meter bar-in-ice. The length of the base was 2.4 miles, very nearly; the probable error of the base due to uncertainty in length of tape was 0.09 inch; the probable error due to measurement was 0.09 inch, and the quantity due to uncertainty in reduction to sea level was 0.04 inch; resulting probable error for base reduced to sea level is 0.14 inch, or about 1-17 inch per mile.

A large variety of instruments were used in the angular work, but it can be broadly stated that in the large figures west of Pike's Peak the 20-inch direction theodolites were employed; that in the region between the Rocky Mountains and the Alleghenies 12-inch theodolites were used; in the Alleghenies the work was executed with 20-inch theodolites; in the Blue Ridge a 30-inch instrument was used at some of the old stations, and 20-inch theodolites at the recent ones; the work about the east end of the arc was executed with 12 or 24-inch instruments.

The eastern portion of the work covered a country not greatly different from that found in many other parts of the world, but the western portion of the United States offered peculiar conditions.

"The tremendous range of a triangulation crossing the continent from ocean to ocean developed conditions which necessitated the application of every refinement known to geodesy in the reduction of the operations,

while the execution of the field work made it imperative upon the observers to devise means for overcoming difficulties that at times seemed insuperable. From California to Colorado the arc advances in the largest consecutive series of polygons in the world; 20 of the lines are over 100 miles in length and one line of sight, from Mt. Uncompahgre to Mt. Ellen, is 182.7 miles in length. In this section signals of wood or stone, aside from their expense, were inadmissible because of the atmospheric conditions which affect the visibility even of the great mountain tops. On the long lines occurring there, the observations were made upon heliotropes, simple and cheap in construction, requiring only the attention of a class of service that could be secured anywhere, and which shone with the brightness of a first-magnitude star through haze and vapor that often made the mountain tops indefinable.

"The value of the length of the arc of the 39th parallel, which is now completed and available for use in the determination of the earth's figure, is 4,224,010 metres. Its astronomical amplitude is $48^{\circ} 16' 47''.83$, and the geodetic amplitude is $48^{\circ} 16' 39''.57$. The probable error of the length value is 26 metres. Computing the value of a similar arc from the elements of Clarke's and Bessel's spheroid, the results differ by 615 metres. The high measure of accuracy of the length of the American arc, and the fact that it lies intermediate between corresponding values deduced from the Clarke and Bessel figures, seems to indicate that only very small changes will ever have to be made in its standard geographical positions because of reference of the work to a more truly representative figure of development."

Pneumatic Appliances in the Foundry.

It has generally been assumed that the foundry is the least modern portion of the machine works, and that improved methods and appliances are less in evidence there than in the tool room and machine shop.

Formerly this was undoubtedly the case, but the rapid introduction of traveling cranes, moulding machines and pneumatic tools has done much to redeem the foundry from the reproach of neglect, which was formerly too often merited.

The use of compressed air especially has

aided in facilitating foundry work, and the share which is due to pneumatic tools in the advancement of foundry work is well shown in a paper by Mr. W. P. Pressinger in a recent issue of the *Journal* of the American Foundrymen's Association.

"The introduction of pneumatic tools in a form marketably perfected for shop or foundry usage dates back but a few years, and their wide-spread adoption, remarkable for its rapidity, is, after all, the most convincing proof of their commercial value. To-day a boiler shop or machine shop devoid of compressed air equipment is a rarity, and if the foundry end of our mechanical community is not so well provided for, I venture to say that it is because the merits and labor-saving properties of pneumatic machinery have not, in the rapid development of the business, been as thoroughly demonstrated to the foundry trade. The day is near at hand, however, when a foundry without pneumatic equipment cannot produce its output in commercial competition with foundries that have adopted it."

One of the earliest and most widely employed of foundry appliances actuated by compressed air is the pneumatic hoist, used both in the straight lift and in the horizontal forms. Air hoists are especially adapted for foundry work, because of the smooth, even motion, so desirable in lifting copes and moulds, and also because of the impossibility of a sudden drop in handling vessels of molten metal.

The pneumatic hammer, in some one of its many forms, has to a great extent done away with the laborious work of chipping castings by hand. The extent to which this most useful tool has extended the range and capacity of the chipper's work is hardly appreciated except by those who have had actual experience and observation, but it has done much to diminish the heavy labor in the foundry, and incidentally to minimize the effect of labor troubles.

Pneumatic sand rammers, air drills, moulding machines, tumbling barrels, etc., are among the many applications of compressed air in the foundry. In addition to these is the sand blast, a most efficient appliance, not used as much as it should be. When it is considered that one man operating a sand blast apparatus, consuming 120 cubic feet of air per minute, can clean more

surface and remove more cores in a given time than is possible for six to ten men to do with hammers, chisels and brushes, apart from the superior character of the work, the possibilities of the apparatus are evident.

"There are, of course, numerous special employments of compressed air in foundry work peculiarly adaptable to individual conditions, but not of general interest or application, but such applications suggest the inevitable conclusion than when once compressed air is available, the number of convenient and economical possibilities that it presents to the progressive operator is surprising, and its field of usefulness broadens with amazing, but none the less gratifying, rapidity. Second only to electricity in its fascinating possibilities, compressed air yields nothing to electricity as a power with properties peculiarly its own, inimitable and unsurpassed in the commercial development of our time, and with the constantly rising standard of efficiency in air compressing machinery, that most important source of power which regulates the value of pneumatic appliances, more widespread adoption is inevitable. Imperfect and wasteful air compressors, possessing the primary virtue of cheapness, but with all the faults in the mechanical calendar, will do more to offset the resultant value to be derived from the use of pneumatic foundry equipment, than labor antagonism, either secret or expressed. Therefore, to derive the utmost benefits from the installation of compressed air machinery, the selection of a compressor should be carefully considered. It is unwise to install a compressor just about equal in capacity to present requirements, good practice being to provide a compressor at least 50 per cent. greater in capacity than immediate necessities demand. Compressors of the duplex type are divisible, permitting the installation and operation of one-half at first, and the other half when the additional capacity is needed. The theoretical capacity of an air compressor, stated in the list of the maker, is not the equivalent of the actual volume of air needed for the service. All makers list their compressors according to theoretical measurement, but the efficiency of the compressor is determined by the volume of air actually delivered with a given consumption of power. The cheap air compressor

usually proves the most expensive. If a water pump fails in its work, or if a steam engine is deficient, the shortcomings are self-evident, but if an air compressor is poorly designed or badly constructed, it may continue in the evil of its ways until the scrap heap claims it for its own; unless, as is more likely, an absolute breakdown calls attention to its deficiencies and shows, all too late, that the hole it has made in the coal pile, added to the cost of keeping it in repair, would have paid a handsome interest on the additional first cost of a properly designed and properly constructed compressor."

Compressed Air Traction in New York.

ALTHOUGH electric traction is undoubtedly the best motive power for tramway service in a great city, especially with the underground trolley system so successfully used in New York and elsewhere, compressed air furnishes a most useful auxiliary. The peculiar shape of New York City renders it extremely desirable that some convenient system for the shorter cross lines, running east and west, should be used to supplement the long north and south electric lines.

An interesting account of the compressed air system used in New York is given in a recent issue of *Compressed Air*, from which we quote:

"The most interesting installation probably ever yet made of motor cars operated by compressed air is that of the Twenty-eighth and Twenty-ninth street cross-town line of the Metropolitan Street Railway Company of New York. It is interesting, especially in the fact that it is a complete installation, no other cars being operated upon the line either night or day but the compressed air cars. In this plant, as elsewhere in compressed air trials, it would seem that the best conditions were not at the first insisted upon. Indeed some mistakes were evidently made. The tracks of this line were cheaply and hastily laid some ten years ago for the light horse cars of that time, with no thought of any heavier traffic, and the track had not been maintained in proper condition, and upon this track the air cars were started. The tracks have since been relaid, and are now in fair condition for the service. It was a rash

and risky thing to do to start a permanent service of this responsible character with a single unit of supply at the power house. However perfect and adequate the apparatus, there are too many possibilities of accident or derangement for the risk to be taken. The compressor in use is also of much larger capacity than the present service requires, it having been designed in contemplation of partially supplying a much more extensive service, which it was hoped would be and is now confidently expected, will be developed. The compressor is easily capable of supplying three times the number of cars now in service, or three times each day the business of that which it at present supplies. The compressor is now run at 27 revolutions per minute, when it might be run at 75 revolutions. No larger force of men, of course, would be required for the increased speed, although a few more men would be required in the car shed."

A tabular statement of performance since September, 1900, shows that with an average of 17 cars running, making round trips of 5.5 miles and a car mileage per day of 94.6 miles, the total cost for all expenses of motive power was 8.31 cents per car mile. The other operating expenses, such as conductors, motormen, roadbed, salaries, etc., etc., was 9.11 cents, making a complete total of 17.42 cents per car mile.

"The above computation is made on a basis of 1,750 miles per day, and although every charge is made for the present operating of only 20 cars, yet from 60 to 80 cars could be operated by the charging and power plant without any material increase in cost, so that for a more extensive installation the cost of operating would be materially reduced.

"The report of the Metropolitan Street Railway Company for the year ending June 30, 1900, gives the relative and actual costs of operating cable, electric and horse railroads. For horse cars the average was 18.98 cents per car mile, the cars being much smaller than those of the other systems; for cable cars, 17.76 cents, and for electric cars, 13.16 cents. The figures were made to include all expenses of operation and maintenance. The estimate given may be assumed to show very nearly the best attainable results by either of the systems at

present. The figures given in the computations relating to the air cars evidently do not give the best results, as the conditions are far from being the best that can be secured with our present knowledge. The compressor, as was stated, is very much too large for the present service and works at a constant loss. The plant has all the disadvantages of a new plant in the inexperience and lack of trained judgment of the men employed. It is to be noted that the expenses for repairs, two cents per car mile, are even now remarkably low for any system except the horse-car."

The Parsons Steam Turbine in America.

ALTHOUGH the Parsons steam turbine has been applied to a variety of uses in England and on the Continent, the most notable applications of it which have been made by Mr. Parsons himself have been in connection with steam navigation. In America, however, probably from the fact that its manufacture is in the hands of the Westinghouse Company, it has mainly been developed in connection with the driving of electric generators. For this reason the paper of Mr. Francis Hodgkinson, recently presented before the Engineers' Society of Western Pennsylvania, and published in the *Proceedings* of the Society, is of peculiar interest.

After reviewing the early conceptions of Hero and of Branca, Mr. Hodgkinson discusses the theoretical forms of nozzles best adapted to produce the proper discharge for turbines of the de Laval type, and then proceeds to describe the Parsons turbine, the general form of which is so well known as to render any very detailed description here unnecessary.

Some interesting information is given in the paper concerning the governing of the turbine. A centrifugal governor is used, the position of the balls acting to control the intermittent admission of the steam. An admission valve is operated mechanically, admitting the steam in puffs, which occur at constant intervals of time. The puffs are of long or short duration, according to the load, and at full load they merge into an almost continuous blast. These puffs have nothing to do with the expansion of the steam, which is taken care of independently at all times by the blades of the turbine.

"The advantages of this intermittance are three-fold. The turbine is at all times using boiler pressure steam, no matter what the load may be. The admission valve is continuously in motion, and consequently gets no opportunity to get stuck. The power to work the relay valve and overcome the inertia of the levers is transmitted through the governor clutch, hence the balls are moved in and out a very small amount at every oscillation of the levers, so that the governor levers in respect to their motion about their points of suspension are never at rest, and consequently when a change of load comes, the governor does not have to overcome the friction at rest, and is always ready to go to its new position."

Theoretically considered, the steam turbine should be the most efficient form of mechanism for the conversion of heat into mechanical energy by the medium of steam.

"A jet of steam issuing through a properly constructed orifice has as much energy as the same steam performing high ratios of expansion behind a piston. In both cases the work to be theoretically abstracted from a given weight is the same. However, there are some practical reasons for expecting better results in the case of the turbine.

"In the design of a three or four stage compound condensing reciprocating engine, it is found that there is no gain in economy by expanding the steam in the low pressure cylinder beyond a terminal pressure of about 5 or 6 lbs. absolute. To do so means very much increasing the volume of the low pressure cylinder, thus increasing the friction of the engine and the weight of reciprocating parts. Moreover, the temperature of saturated steam, as these low pressures are reached, falls off much more rapidly; hence there are greater losses, due to condensation and re-evaporation, than would be gained by a more complete expansion. In the steam turbine, no such limits exist. The extra volume of the low pressure end does not add to the friction. The temperature conditions from end to end remain always the same, and hence such losses as condensation and re-evaporation are not in evidence.

"Turbines are constructed to utilize the energy of the steam down to the utmost limits. A condensing steam turbine, when in operation, affords a striking example of

the conversion of heat into energy. The temperature of the walls of the cylinder at the high pressure end, about 365° F., falls in the distance of three or four feet to a temperature of about 126° at the low pressure end."

Mr. Hodgkinson gives data from tests made upon a 300 kilowatt turbine at the Westinghouse Air Brake Company's works, in which it is shown that with a boiler pressure of 125 pounds per square inch, and a vacuum of 26 to 27 inches of mercury, at 3,600 revolutions per minute, the steam consumption was 16.4 pounds per *electrical* horse-power-hour at full load, rising only to 22 pounds at one-fourth load.

At the high speeds employed with steam turbines especial care must be taken in balancing the rotating parts, and the paper gives some interesting information about the methods of securing a true running balance. These are not greatly different from those which have long obtained in the construction of high-speed woodworking machinery, but their application to steam machinery is of comparatively recent date.

The especial applicability of the Parsons turbine for driving alternators in multiple lies in the fact that the angular velocity of the machine is practically uniform at all points in every revolution, a condition not readily attainable in reciprocating engines. Crank engines, to be adapted to this class of work, must be designed with this especial end in view, and especially liberal proportions given to the fly wheel, together with proper governor adjustment, while with the turbine the uniformity of rotation is an inherent feature in the construction.

It is interesting to note that in the course of the discussion upon Mr. Hodgkinson's paper it appeared that the cost of a steam-turbine generator is such that it can be sold at the same price as a regular Westinghouse compound engine and generator outfit.

Electric Power in Workshops.

At a recent joint meeting of the mechanical and electrical sections of the Franklin Institute there was recently held a very interesting discussion upon the subject of the electrical distribution of power in workshops, which revealed to a remarkable degree the extent to which electrical driving has already found favor.

From the report of the discussion in the *Journal* of the Franklin Institute some points may be taken, showing the general trend of opinion.

Professor F. B. Crocker, of New York, called attention to the fact that this new combination of the electrical and mechanical branches of engineering is not much more than five years old, and yet its introduction and success have been so general that it promises to be adopted almost universally in the next five or ten years.

Professor Crocker enumerated serially the advantages of electrical driving very fully, showing that there is a material saving of power by its use, although this is not the most important advantage, since the power-cost is only about 3 per cent. of the total expense. The absence of heavy overhead shafting enables a considerable economy of the cost of buildings to be made, and this is a matter of importance when new buildings are being planned. The first cost of the electrical equipment is slightly greater than that of shafting and belting, but the depreciation can be made much less, as can the cost for lubrication.

A great advantage in electrical driving is the freedom which it permits in the arrangement of machinery. The location and direction of shafting need no longer be considered, and the machines may be placed in the best position for operation, there being no necessity for placing them in rows, or placed at any particular angle with respect to each other. The advantage of clear head-room is also great, and comparison between the old method and the new in actual service is all that is needed to emphasize this advantage. Electrical machinery is much cleaner than overhead shafting, and this alone has an important influence upon the health of employees. As an example it may be noted that in the Government Printing Office, at Washington, the sick list decreased 20 to 40 per cent. after electric motors were introduced.

An important advantage of electrical driving lies in the transmission of power to detached buildings, and in the enlargement and extension of plants the buildings, like the machinery within them, can be located for general convenience, and not with special regard to supplying them with power.

A most practical example of the advan-

tages following the introduction of electrical driving for machine tools is found in the case of the Baldwin Locomotive Works, at Philadelphia. According to the statements of Mr. Samuel M. Vauclain, the superintendent of the works, the advantages seen in the operation of electrically operated traveling cranes led them to extend the system to many of their machine tools. The advantages reside both in saving of floor space and in operating expenses, as appear from the statement that the abandonment of electrical driving would cause an increase of 20 to 25 per cent. in the cost of the manufactured product for labor alone, while if it were not for electric driving the Baldwin works would have to cover 40 per cent. more floor space than they now do to maintain their present output.

Mr. G. S. Dunn referred especially to the speed regulation of the electric motor, and showed the methods of effecting the important function of speed control, comparing the method of control by resistance with that by variation of voltage. He also referred to the system of providing for the establishment throughout the shop of multiple voltage circuits, maintaining permanently six or more fixed voltages of different values, to any one of which the motor may be connected at will.

The results of the introduction of electric driving at the Government Printing Office, at Washington, confirm fully those cited from the Baldwin Locomotive Works. Here a plant costing \$50,000 showed a total gain of 16 $\frac{2}{3}$ per cent. on the investment, which, less 6 $\frac{2}{3}$ per cent. for insurance, taxes and interest, gives a clear gain of 10 per cent. on the expenditures for coal and gas alone.

The ability to rearrange machinery irrespective of line shafting made all space equally available, and permitted the addition of forty printing presses, thus increasing the working floor space without requiring increase of actual floor area. It was estimated that the increase in production in the presses was at least 10 per cent., and the average earning capacity being \$10 per day, the net gain was sufficient to pay for the entire plant in five years.

The most important outcome of the discussion was the emphasis laid upon the fact that the indirect gains due to electric

driving are far greater than the mere power economy. In many cases, undoubtedly, electric driving has been examined and rejected solely upon the moderate economy showing presented. The data as to labor economy, increased efficiency of floor space, advantages in the arrangement of machinery, and increased output, are now so clearly shown as to place the whole question on a far higher and broader plane, and the result will certainly be as great a transformation in machine driving during the next ten years as has been experienced in tramway traction during the decade just closed.

Water Filtration at Pittsburg.

WATER filtration is undoubtedly destined ultimately to form an essential question for every large city, and for this reason the paper of Mr. Morris Knowles, in the *Journal* of the Association of Engineering Societies, upon the experimental filtration plant at Pittsburg, will doubtless be read with interest for the definite information which it furnishes.

This experimental plant is the outcome of the appointment of a special commission by the City Council for the purpose of investigating the subject with regard to the proposed construction of a plant for Pittsburg, Mr. Allen Hazen, of New York, being the consulting engineer for the commission. Since 1897 experiments have been conducted with sand filters, mechanical filters, and tile filters, and Mr. Knowles' paper gives the results of the work, more fully detailed in the report of the commission.

The slow sand filter plant consisted of a settling basin of 38,800 gallons' capacity and two filter beds, each bed being 25 ft. 3 in. by 11 ft. in area, with a depth of sand, originally of 5 feet, ultimately diminishing to 4.2 feet.

The mechanical filters tested were those known as the Jewell and the Warren types, both using sulphate of alumina as a coagulant, and differing mainly in mechanical details; while the tile filter was that known as the Wormser.

So far as bacterial efficiency was concerned, the slow sand filter showed slightly higher results than the others, an average for the year 1899 showing that between 98 and 99 per cent. of the bacteria in the raw water

were removed by filtration. The average for six months for the mechanical filters showed the Warren to have an efficiency of 98.25 per cent., and the Jewell 97.45 per cent. The tile filter also gave an efficiency of 97.40 per cent.

Under these circumstances there appears to be no doubt that water such as is available for use at Pittsburg can be made altogether satisfactory for domestic use, notwithstanding the fact that the Allegheny river, from which by far the greater portion of the supply is derived, is often very muddy and is polluted by sewage from many cities, towns, and mining villages, together with considerable mine drainage at times.

The use of water for industrial purposes is an important consideration in Pittsburg, or, indeed, in any large manufacturing city. It was, therefore, considered advisable to learn what the effect would be of clarifying and filtering the Allegheny River water prior to its use in boilers.

Three new 25 H. P. boilers were kindly loaned by the Oil Well Supply Company for the purpose of an experiment in this line. Boiler No. 1 was supplied with the effluent from the sand filters, No. 2 with the effluent from the mechanical filters, and No. 3 with the unclarified river water. When these boilers had been in service for about two and one-half months they were blown off hot. Samples of scale were collected, and an examination was made of the interior of each.

The result of these tests showed that with the water from the sand filters the scale was composed of 53 per cent. of calcium carbonate, 13 per cent. of calcium sulphate, and 25 per cent. of magnesium carbonate. The water from the mechanical filters gave a scale containing only 27 per cent. of calcium carbonate, while the calcium sulphate rose to 53 per cent., and the magnesium carbonate fell to 12 per cent. With the raw river water 68 per cent. of the scale was composed of insoluble matter, and 16 per cent. of iron and aluminum oxides, the calcium salts being present in very small proportion.

It will be seen that the scale from boiler (No. 1), using the effluent from the sand filters, was composed largely of the carbonates of calcium and magnesium, which are not as troublesome as the sulphates. It was said that, by cooling down slowly, the for-

mation of this kind of scale could have been, in a measure, prevented. It will be noticed, however, that the scale from boiler (No. 2), using the effluent from the mechanical filters, was composed largely of sulphate of calcium, which is what would be expected from the chemical action caused by the addition of sulphate of alumina to the water. The scale upon boiler (No. 3), using the unclarified river water, was soft, and composed largely of mud and insoluble matter, material which could have been largely removed by judicious blowing out from time to time.

The statement of the practical boiler mechanic who examined the interiors after the experimental use, was that boiler No. 3 was in the best condition. This problem, however, must be considered as by no means settled by such a limited experiment.

The St. Croix Hydraulic Power Plant.

THE development of natural sources of power and the transmission of the energy electrically to points where it can be made available, continues to advance in America, and a recent issue of the *Transactions* of the American Institute of Electrical Engineers contains an account of one of the latest additions to the list, being a description of the St. Croix power plant on the Apple River, in Wisconsin, by Henry Floy.

This plant is interesting for several reasons. The total amount of power available is not very great, there being a natural fall of about 30 feet, which was increased by a dam to a total head of 82 feet, and the minimum flow of the river is computed to furnish about 200 horse power, and during most of the year nearly twice that amount.

The plant has been designed to transmit current to St. Paul, a distance of 27 miles, for use by the St. Paul Gas Co., this plant permitting the shutting down of four exist-

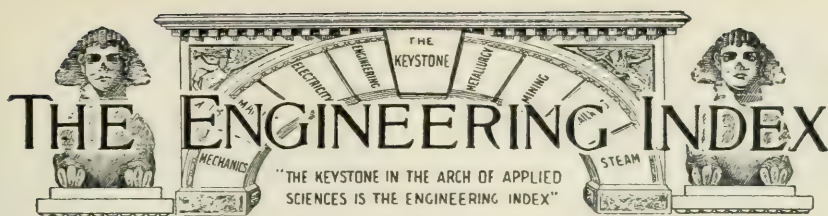
ing steam stations and avoiding the necessity of building a modern steam plant and providing nearly twice the saleable output of the old stations.

The paper gives details of the construction of the dam, which is of arched form and 350 feet in length and 47 feet high. It is made with a masonry core, resting on concrete foundation and enclosed in concrete facings, and as completed is practically a concrete monolith.

The generating station contains four sets of turbines, each set consisting of two 36 inch Victor wheels, and there is room for a fifth set. Each pair of wheels is placed on a horizontal shaft extending through the wall and connected to a 750 kilowatt generator. The generators are three-phase, 800 volt, 60 cycle machines, running at 300 revolutions per minute, this pressure being transformed directly up to 25,000 volts for delivery to the line. There are two three-wire, three-phase transmission circuits, each consisting of 24½ miles of overhead bare copper wires, and three miles of underground cables connecting the generating station with the distributing station in St. Paul. The paper gives much detailed information about the 25,000 volt underground transmission, the ultimate success of this portion of the line being yet to show how it can stand the test of time.

The paper gives much interesting information about the transmission line, including the results of tests, the line having been successfully tested to a pressure of 30,400 volts, the general results of the tests being given with diagrams, showing the details.

The whole account is a valuable contribution to hydraulic, mechanical, and electrical engineering, showing, as it does, how a comparatively small stream at a distance from a large city may be harnessed and its energy transmitted, to the entire supersession of existing steam plants.



The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language*; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of \$1.00; G, of \$1.20; and H, of \$1.60. In ordering, care should be taken to give the *number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for \$2.00, thirty-three for \$5, and one hundred for \$15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of *THE ENGINEERING MAGAZINE* at 10 cts. per month, or \$1.00 a year; to non-subscribers, 25 cts. per month, or \$3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

- | | |
|---|---|
| American Architect. <i>w</i> . Boston, U. S. A. | Automobile Magazine. <i>m</i> . New York. |
| American Electrician. <i>m</i> . New York. | Automotor & Horseless Vehicle JI. <i>m</i> . London. |
| Am. Engineer and Railroad Journal. <i>m</i> . New York. | Brick Builder. <i>m</i> . Boston, U. S. A. |
| American Gas Light Journal. <i>w</i> . New York. | British Architect. <i>w</i> . London. |
| American Geologist. <i>m</i> . Minneapolis, U. S. A. | Brit. Columbia Mining Rec. <i>m</i> . Victoria, B. C. |
| American JI. of Science. <i>m</i> . New Haven, U. S. A. | Builder. <i>w</i> . London. |
| American Machinist. <i>w</i> . New York. | Bulletin Am. Iron and Steel Asso. <i>w</i> . Philadelphia, U. S. A. |
| Am. Manufacturer and Iron World. <i>w</i> . Pittsburg, U. S. A. | Bulletin de la Société d'Encouragement. <i>m</i> . Paris. |
| American Shipbuilder. <i>w</i> . New York. | Bulletin of Dept. of Labor. <i>b-m</i> . Washington. |
| Annales des Pontes et Chaussées. <i>m</i> . Paris. | Bulletin of the Univ. of Wisconsin, Madison, U. S. A. |
| Architect. <i>w</i> . London. | Bull. Int. Railway Congress. <i>m</i> . Brussels. |
| Architectural Record. <i>qr</i> . New York. | California Architect. <i>m</i> . San Francisco, U. S. A. |
| Architectural Review. <i>s-q</i> . Boston, U. S. A. | Canadian Architect. <i>m</i> . Toronto. |
| Architect's and Builder's Magazine. <i>m</i> . New York. | |
| Australian Mining Standard. <i>w</i> . Sydney. | |

- Canadian Electrical News. *m.* Toronto.
 Canadian Engineer. *m.* Montreal.
 Canadian Mining Review. *m.* Ottawa.
 Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
 Colliery Guardian. *w.* London.
 Compressed Air. *m.* New York.
 Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
 Consular Reports. *m.* Washington.
 Contemporary Review. *m.* London.
 Deutsche Bauzeitung. *b-w.* Berlin.
 Domestic Engineering. *m.* Chicago.
 Eclairage Electrique. *w.* Paris.
 Electrical Engineer. *w.* London.
 Electrical Review. *w.* London.
 Electrical Review. *w.* New York.
 Electrical World and Engineer. *w.* New York.
 Electrician. *w.* London.
 Electricien. *w.* Paris.
 Electricity. *w.* London.
 Electricity. *w.* New York.
 Elektrizität. *b-w.* Leipzig.
 Elektrochemische Zeitschrift. *m.* Berlin.
 Elektrotechnische Zeitschrift. *w.* Berlin.
 Elettricita. *w.* Milan.
 Engineer. *w.* London.
 Engineer. *s-m.* Cleveland, U. S. A.
 Engineers' Gazette. *m.* London.
 Engineering. *w.* London.
 Engineering and Mining Journal. *w.* New York.
 Engineering Magazine. *m.* New York & London.
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
 Fire and Water. *w.* New York.
 Foundry. *m.* Detroit.
 Gas Engineers' Mag. *m.* Birmingham.
 Gas World. *w.* London.
 Génie Civil. *w.* Paris.
 Gesundheits-Ingenieur. *s-m.* München.
 Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
 Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
 Horseless Age. *m.* New York.
 Ice and Refrigeration. *m.* New York.
 Indian and Eastern Engineer. *m.* Calcutta.
 Iron Age. *w.* New York.
 Iron and Coal Trades Review. *w.* London.
 Iron & Steel Trades Journal. *w.* London.
 Iron Trade Review. *w.* Cleveland.
 Journal Assn. Eng. Societies. *m.* Philadelphia, U. S. A.
 Journal of Electricity. *m.* San Francisco.
 Journal Franklin Institute. *m.* Philadelphia.
 Journal of Gas Lighting. *w.* London.
 Journal Royal Inst. of Brit. Arch. *s-gr.* London.
 Journal of Sanitary Institute. *qr.* London.
 Journal of the Society of Arts. *w.* London.
 Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
 Journal Western Soc. of Eng. *b-m.* Chicago.
 Journal of Worcester Poly. Inst., Worcester, Mass.
 L'Energie Electrique. *w.* Paris.
 Locomotive. *m.* Hartford, U. S. A.
 Locomotive Engineering. *m.* New York.
 Machinery. *m.* London.
 Machinery. *m.* New York.
 Marine Engineering. *m.* New York.
 Marine Review. *w.* Cleveland, U. S. A.
 Metal Worker. *w.* New York.
 Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
 Mines and Minerals. *m.* Scranton, U. S. A.
 Mining and Sci. Press. *w.* San Francisco, U. S. A.
 Mining Reporter. *w.* Denver, U. S. A.
 Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
 Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
 Modern Machinery. *m.* Chicago.
 Moniteur des Architects. *m.* Paris.
 Moniteur Industriel. *w.* Paris.
 Municipal Engineering. *m.* Indianapolis, U. S. A.
 National Builder. *m.* Chicago.
 Nature. *w.* London.
 Nature. *w.* Paris.
 Nautical Gazette. *w.* New York.
 New Zealand Mines Record. *m.* Wellington.
 Nineteenth Century. *m.* London.
 North American Review. *m.* New York.
 Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
 Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
 Ores and Metals. *w.* Denver, U. S. A.
 Plumber and Decorator. *m.* London.
 Popular Science Monthly. *m.* New York.
 Power. *m.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Soc. Civil Engineers. *m.* New York.
 Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
 Proceedings St. Louis R'way Club, *m.* St. Louis, U. S. A.
 Progressive Age. *s-m.* New York.
 Railroad Car Journal. *m.* New York.
 Railroad Gazette. *w.* New York.
 Railway Age. *w.* Chicago.
 Railway & Engineering Review. *w.* Chicago.
 Review of Reviews. *m.* London & New York.
 Revue de Mécanique. *m.* Paris.
 Revue Gen. des Chemins de Fer. *m.* Paris.
 Revue Technique. *b-m.* Paris.
 Revue Universelle des Mines. *m.* Liège.
 Rivista Marittima. *m.* Rome.
 Sanitary Plumber. *s-m.* New York.
 Schweizerische Bauzeitung. *w.* Zürich.
 Scientific American. *w.* New York.
 Scientific Am. Supplement. *w.* New York.
 Stahl und Eisen. *s-m.* Düsseldorf.
 Stevens' Institute Indicator. *qr.* Hoboken, U. S. A.
 Stone. *m.* New York.
 Street Railway Journal. *m.* New York.
 Street Railway Review. *m.* Chicago.
 Telephone Magazine. *m.* Chicago.
 Tramway & Railway World. *m.* London.
 Trans. Am. Ins. Electrical Eng. *m.* New York.
 Trans. Am. Ins. of Mining Eng. New York.
 Trans. Am. Soc. of Civil Eng. *m.* New York.
 Trans. Am. Soc. of Heat & Ven. Eng. New York.
 Trans. Am. Soc. Mech. Engineers. New York.
 Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
 Transport. *w.* London.
 Western Electrician. *w.* Chicago.
 Wiener Bauindustrie Zeitung. *w.* Vienna.
 Yacht. *w.* Paris.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
 Zeitschrift für Elektrochemie. *w.* Halle a. S.
 Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Chimney.

The Boston Elevated Railway's Chimney at Lincoln Wharf. Illustrated description of a 251-ft. brick stack having new details at the flues. 500 w. Eng Rec—Dec. 22, 1900. No. 38297.

Fireproofing.

Non-Flammable Materials. An illustrated account of tests made of materials rendered non-flammable, by the British fire-prevention committee. 1200 w. Fire & Water—Dec. 1, 1900. No. 38040.

The Fire-proofing of the Government Printing Office, at Washington, D. C. An account of the competition for construction of the fire-proof floors and steel protection, with illustrations of the designs submitted by the successful bidders, and those executed by the Government. 1300 w. Br Build—Nov., 1900. No. 37949 D.

Ice Houses.

Cheap Ice Houses. Suggestions for a farmer's ice house, scheme for a 50-ton ice house, various floors, a 5,000-ton house, etc. Ill. 2500 w. Ice & Refrig—Dec., 1900. No. 38022 C.

Materials.

Building Materials at the Paris Exhibition, 1900. A review of the exhibits of this class, with comments on the attempted classification. 3200 w. Engng—Dec. 7, 1900. Serial. 1st part. No. 38191 A.

Rolled Joists.

The Use of Rolled Joists in Construction. A. T. Walmisley. Read before the British Archt. Assn. An interesting and valuable paper, with many diagrams, and short general discussion. 8700 w. Builder—Dec. 1, 1900. No. 38101 A.

Roof Trusses.

Joints in Wooden Trusses. Letters from H. S. Jacoby and F. E. Kidder on the working stresses to be adopted in designing such trusses. 1300 w. Eng Rec—Dec. 29, 1900. No. 38428.

Sprinklers.

Eliminating the Conflagration Hazard. Everett U. Crosby. Devoted to a discussion of the possible elimination of conflagrations in cities by the universal installation of automatic sprinkler systems. Gives information of the system in an appendix, and also a general discussion.

11500 w. Jour N. E. Water Wks Assn—Dec., 1900. No. 38142 E.

HEATING AND VENTILATION.

Blowing Fans.

Methods of Testing Blowing Fans. R. C. Carpenter. Read before the Am. Soc. of Heat. & Ven. Engs. Considers certain difficulties experienced in testing, the methods, etc. 4600 w. Dom Engng—Dec. 20, 1900. No. 38261 C.

Flanges.

The Standardization of Flanges. Robert E. Atkinson. Read at the Oct. meeting of the Inst. of Heat. and Ven. Engs., in London. A general discussion of the subject. 4800 w. Plumb & Dec—Dec. 1, 1900. No. 38213 A.

Greenhouses.

A New Method of Steam Heating for Greenhouses. T. Eckhardt, in the *Florists' Exchange*. Illustrated description of a new method of heating greenhouses for tropical plants, with a comment by L. R. Taft. 3000 w. Met Work—Dec. 1, 1900. No. 37954.

Public Library.

Ventilation and Heating of the Atlanta, Ga., Public Library. Illustrated description of the new Carnegie library heating plant, which includes an indirect apparatus for most of the building and a direct apparatus, supplemented by direct-indirect radiation, for the stock-room. 1500 w. Eng Rec—Dec. 1, 1900. No. 37947.

Radiators.

Surface of Radiators in Room Heating. Ernest T. Child. A comparison of the methods of determining the proper amount of steam radiating surface. 2700 w. Gas Eng's Mag—Dec. 10, 1900. No. 38465 A.

Drainage.

Essential Features of House Drainage. Rudolph Hering. Considers in detail the requirements of a perfect system of house drainage. 4900 w. Dom Engng—Dec. 20, 1900. No. 38257 C.

Pipes Freezing.

Freezing of Soil and Vent Pipes. A copy of inquiries sent out relating to this subject, and the replies received. 1800 w. Dom Engng—Dec. 20, 1900. No. 38258 C.

Plumbing.

Practical Plumbing. An address on the proper installation of sewer, waste,

soil and ventilation pipes. 3200 w. Dom Engng—Dec. 20, 1900. No. 38259 C.

Residence.

Plumbing Details in the Residence of Dr. E. H. Dunham. Illustrated description of the numerous special features in a large New York residence; these include details of the water-supply apparatus as well as the drainage system. 2200 w. Eng Rec—Dec. 22, 1900. No. 38401.

Soldering.

Burning and Blow Pipe Soldering. An illustrated article on the use of the oxyhydrogen flame for lead burning. 2500 w. Met Work—Dec. 15, 1900. No. 38177.

Water Closets.

A History of Water Closets. Glenn Brown. Read before the Am. Inst. of Archts. Reviews the history, and describes early types. Ill. 1600 w. Dom Engng—Dec. 20, 1900. Serial. 1st part. No. 38260 C.

Water Service.

Water Service in a Suburban Residence. Illustrated description of a piece of plumbing work which has given excellent satisfaction. 1300 w. Met Work—Dec. 1, 1900. No. 37955.

MISCELLANY.

Elevators.

The "Escalator," or Continuous Elevator. Illustrates and describes this device, as shown at the Paris Exhibition. 1200 w. Engng—Nov. 30, 1900. No. 38112 A.

The New Elevators of the Eiffel Tower. From *La Nature*. An illustrated description of changes made, necessitated by the installation of new elevators, and the difficulties overcome. 1100 w. Sci Am Sup—Dec. 8, 1900. No. 38050.

The New Fives-Lille Elevators at the Eiffel Tower (Les Nouveaux Ascenseurs Fives-Lille à la Tour Eiffel). G. Leugny. A description of the new and enlarged elevator system installed for the service of the exposition of 1900. 2000 w. Revue Technique—Nov. 25, 1900. No. 38324 D.

Landscape Architecture.

Landscape in Connection with Public Buildings in Washington. Abstract of a paper by F. L. Olmsted, Jr., before the Am. Inst. of Archts., explaining the unfortunate results of a failure to group the public buildings of Washington in harmony with l'Enfant's project. 3300 w. Eng Rec—Dec. 29, 1900. No. 38426.

CIVIL ENGINEERING

BRIDGES.

Accidents.

Some Peculiar Railroad Bridge Accidents. J. I. Boggs. An account of accidents on the Houston & Texas Central Ry., showing the remarkable performance of some old designs in railroad bridges. 800 w. Pro Am Soc of Civ Engs—Nov., 1900. No. 37978 E.

Bridge Raising.

Raising the Boston Bridge, Near McKeesport. Illustrated description of the method of raising half of a cantilever bridge by adding supports 14 ft. high on the top of the pier. 900 w. Eng Rec—Dec. 15, 1900. No. 38180.

Concrete.

Highway Bridges of Concrete. Daniel B. Luten. Illustrates and describes the construction, and considers the adaptability of this material for bridge designs, and the cost. 1000 w. Munic Engng—Dec., 1900. No. 37988 C.

Concrete-Steel.

The Green and Goat Islands Concrete-Steel Bridges at Niagara Falls, N. Y. An illustrated account of the new bridges under construction at the points named,

and the difficulties met. 2000 w. Eng News—Dec. 6, 1900. No. 38078.

Development.

The Developments of the Nineteenth Century in Bridge Design and Construction. A brief historical review of bridge building and materials used, based on articles by Prof. G. C. Mehrtens, published in *Zeitschrift des Vereines Deutscher Ingenieure*. 2000 w. Eng News—Dec. 13, 1900. No. 38164.

Highway Bridge.

Economical Steel and Masonry Highway Bridge Work at Rye, N. Y. Illustrates and describes a steel girder and concrete floor bridge over Blind Brook. 700 w. Eng News—Dec. 13, 1900. No. 38165.

London Bridge.

The Widening of London Bridge. Briefly reviews the history of the bridge and illustrates and describes the present scheme, chiefly devoted to dealing with the lateral expansion of the footways. 2500 w. Engr, Lond—Dec. 21, 1900. No. 38453 A.

The Widening of London Bridge. Editorial, with illustrations on the proposed alterations, which will widen the foot-

ways. 1300 w. Builder—Dec. 8, 1900. No. 38218 A.

Rebuilding.

Reinforcing and Rebuilding the Cornwall Bridge Piers. Illustrated description of a steel caisson and coffer-dam placed about a masonry pier and filled with concrete for the purpose of increasing the stability of the pier. 2000 w. Eng Rec—Dec. 29, 1900. No. 38421.

Requirements.

Electric Railway Bridges. An editorial discussion of the new requirements of the Massachusetts Board of Railroad Commissioners for bridges supporting electric railways. 1000 w. Eng Rec—Dec. 29, 1900. No. 38419.

Rhine.

The Railway Bridge Over the Rhine at Worms (Die Eisenbahnbrücke über den Rhein bei Worms). H. Geibel. A very full account of this important structure, with details of the construction and photographs in various stages of erection. 12000 w. Zeitschr d Ver Deutscher Ing—Dec. 1, 1900. No. 38317 D.

Riveting.

A Direct Method of Spacing Rivets and Finding the Position, etc., of Stiffeners in Plate Girders. E. Schmitt. Presents a graphical method of finding the rivet spacing, etc., of plate girders which greatly lessens the labor. 4500 w. Pro Am Soc of Civ Eng—Nov., 1900. No. 37977 E.

Specifications.

The American Bridge Company's New Specifications. A series of extracts from the specifications for steel railway bridges, giving the more important changes from previous specifications and an explanation of the reasons for certain of them. Also an editorial discussion of the value of these specifications. 3800 w. Eng Rec—Dec. 1, 1900. No. 37948.

Stresses.

Some Bridge Matters. Editorial discussion of matters relating to bridge design, and the straining action on rivets, etc. 2000 w. Engng—Nov. 23, 1900. No. 37995 A.

Swing-Bridges.

Swing-Bridges Over the Weaver. Illustrates and describes the new swing-bridges over the river at Northwich, where the salt industry often causes subsidence, and thus made the designing more than usually difficult to meet the conditions. 3000 w. Engng—Dec. 14, 1900. No. 38268 A.

Viaduct.

The New Kinzua Viaduct. Illustrated description of the general features, details of construction and methods of erection

of a heavy steel viaduct 2,053 ft. long and 301 ft. in maximum height. 3000 w. Eng Rec—Dec. 1, 1900. No. 37943.

The New Kinzua Viaduct. An editorial discussion of the difference in design between the old and new structures. 1000 w. Eng Rec—Dec. 22, 1900. No. 38292.

The Kinzua Viaduct. Illustrated detailed description of the reconstruction of a heavy steel viaduct on the Bradford Div. of the Erie R. R. 3200 w. R R Gaz—Nov. 30, 1900. No. 37972.

The Kinzua Viaduct of the Erie Railroad Company. C. R. Grimm. An illustrated detailed description of this reconstructed viaduct, with reasons for the design chosen, and information of interest. 3000 w. Pro Am Soc of Civ Eng—Nov., 1900. No. 37979 E.

Wooden Bridge.

The Old Y Bridge at Zanesville. Illustrated description of the wooden Burr bridge, some of its trusses of 150-ft. span, built in 1831-32. 800 w. Eng Rec—Dec. 22, 1900. No. 38295.

CONSTRUCTION.

Dams.

Building of the Great Wachusett Dam. J. A. Stewart. An illustrated account of a dam that will provide the city of Boston with an extensive storage basin of capacity only surpassed by one other in the world. 1100 w. Sci Am Sup—Dec. 15, 1900. No. 38140.

The Cascade Rock-Fill on the Erie R. R. Sketch plan and illustration, with brief description. 600 w. Eng News—Dec. 27, 1900. No. 38446.

The Latest Soundings at the Break in the Austin Dam. Thomas U. Taylor. A report of investigations made in Oct. and Nov., 1900. Ill. 1400 w. Eng News—Dec. 6, 1900. No. 38081.

Earthwork.

Rapid Earthwork Calculation. H. P. Gillette. An explanation of method. 2500 w. Eng News—Dec. 12, 1900. No. 38166.

Framework.

The Theory of Simple Frameworks (Beitrag zur Theorie des einfachen Fachwerkbauwerks). Prof. Ramisch. A graphical examination of simple truss forms. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 16, 1900. No. 38309 B.

Roof Trusses.

See Architectural Engineering, Construction.

Tunneling.

The East Boston Tunnel Shield. Illustrated description of a roof shield for a tunnel under Boston harbor, noteworthy for the provision made for bulk-heading its front, when necessary. 900 w. Eng Rec—Dec. 20, 1900. No. 38423.

Water-Jet.

The Water-Jet as an Aid to Engineering Construction. L. Y. Schermerhorn. Gives a review of the applications of the water-jet to the work of the engineer, giving the history of the early development, and typical cases where the results were satisfactory. Also discussion. 9000 w. Pro Engs' Club of Phila.—Nov., 1900. No. 38019 D.

HYDRAULIC AND MARINE.**Canals.**

A Remarkable Old Waterway. Illustration and descriptive account of the Kennet and Avon Canal, and Devizes Locks. 2000 w. Engr, Lond—Nov. 30, 1900. No. 38117 A.

Canals from the Lakes to New York. Discussion of papers by Joseph Mayer and George Y. Wisner. 7000 w. Pro Am Soc of Civ Engs—Nov., 1900. No. 37980 E.

Canals from the Lakes to New York. Continued discussion of papers by Joseph Mayer and George Y. Wisner. 19300 w. Pro Am Soc of Civ Engs—Dec., 1900. No. 38444 E.

Increased Transportation Facilities. Albert H. Scherzer. A plea for the development of inland waterways, especially a ship canal in United States territory from the Great Lakes to the Seas, in advance of building an isthmian canal. 1800 w. Marine Rev—Nov. 29, 1900. No. 37982.

The Preliminary Report of the Isthmian Canal Commission. Abstract of the first part of this report, dealing with dimensions, routes, harbors, etc. 5400 w. Eng News—Dec. 20, 1900. Serial. 1st part. No. 38229.

The Isthmian Canal Commission's Report. The full text of the first part of the report submitted on Nov. 30; it covers the organization of the Commission's working force, a total of over 800 men, the investigations made on foreign canals, the results of the examination of the work at Panama, special surveys in the Darien country, and the examination of the Nicaragua Canal project. Also an editorial on this portion of the report. 10400 w. Eng Rec—Dec. 8, 1900. Serial. 1st part. No. 38085.

Docks.

Dock Extensions in the Bristol Channel. Information concerning proposed extensions at various ports. 2200 w. Engr, Lond—Dec. 14, 1900. No. 38265 A.

40,000-Ton Capacity Ore Dock of the Great Northern Ry., at West Superior, Wis. Drawings, and brief statement of dimensions, with comment on the excellence of the work. 700 w. Eng News—Dec. 20, 1900. No. 38228.

The Construction of the Docks on the Moldau, near Prague (Baufortschritt bei

dem Flosshafen auf der Kaiserwiese au der Moldau bei Prag). M. Machulka. Describing and illustrating the work on the new basins, of 34 acres in extent, now under construction near Prague. 2500 w. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1900. No. 38347 D.

The New Hoboken Terminal of the North German Lloyd Line. Illustrated description of the piers and buildings to be erected on the site of those destroyed in the summer of 1900. The fireproofing and structural steel-work contain many unusual features. 2700 w. Eng Rec—Dec. 22, 1900. No. 38293.

Warned by the Conflagration. Illustration of the new terminals and piers to be built for the North German Lloyd Co., in Hoboken, N. J., with brief description. 800 w. Fire & Water—Dec. 22, 1900. No. 38415.

Dredging.

A New Method of Applying Cutting Machinery to Suction Dredges. George Higgins. Read before the Victoria Inst. of Engs. Explains the need of cutters in dealing with certain material, and gives illustrated description of machinery to be applied to a suction dredge in New South Wales. 3500 w. Prac Engr—Nov. 23, 1900. Serial. 1st part. No. 38011 A.

Filtration.

Description of Experimental Filter Plant at Pittsburg, and Results of Experiments. Morris Knowles. An account of the investigations which were carried on at the experimental filter plant, giving a description of the apparatus used, views of interesting details, and a summary of results. Ill. 10000 w. Jour N. E. Water Wks Assn—Dec., 1900. No. 38144 E.

The Lower Roxborough Filter Plant at Philadelphia. Illustrated description of five covered sand filters and a covered clear water basin, all of concrete, having a capacity of 6,400,000 gallons in 24 hours with one filter idle. The work involves a large amount of special concrete construction. 3400 w. Eng Rec—Dec. 8, 1900. No. 38083.

The Construction of Gravity Sand Filters at Nyack, N. Y. G. N. Houston. Gives illustrated description of plant, and details of construction, stating the conditions to be met and the methods adopted. 3500 w. Pro Am Soc of Civ Engs—Dec., 1900. No. 38442 E.

Results of Water Filtration at Albany. Dr. Martin MacHarg. Extracts from a paper read before the Albany Co. Med. Soc. concerning the reduction in typhoid fever in Albany since the introduction of filtered water. 700 w. Eng Rec—Dec. 1, 1900. No. 37946.

The English System of Water Filtration. Floyd Davis. Describes the English methods of sand filtration and the

care needed. 1500 w. *Munic Engng* Dec., 1900. No. 37990 C.

Flow.

Hydraulic Theories on the Flow of Water. A letter from Charles H. Tutton, on the formulas deducible by various assumptions from elementary laws of physics. 2000 w. *Eng Rec*—Dec. 29, 1900. No. 38429.

Measuring the Flow of Water from Pipes. W. H. Booth. Describes a method of making rapid approximations. 600 w. *Am Mach*—Dec. 27, 1900. No. 38413.

Mr. Sullivan's Hydraulic Formula. A letter from I. P. Church comparing a large number of formulas for the flow of water in open channels and long pipes. 400 w. *Eng Rec*—Dec. 29, 1900. No. 38427.

River Improvement.

The Results of the Improvement of Navigable Streams (Die Erfolge der Fahrwasserbesserung Schiffbarer Flüsse). A. v. Weber-Ebenhoff. A review of the commercial results which have followed river improvement works in Austria and Germany during the past ten years. 7500 w. *Oesterr Monatschr f d Oeffent Baudienst*—Dec., 1900. No. 38347 D.

Works for the Improvement of the Mississippi River, as Shown at the Paris Exposition of 1900. Describes the interesting exhibits of models, drawings and maps of the various works. 2400 w. *Ry & Engng Rev*—Dec. 15, 1900. No. 38199.

Standpipe.

Deterioration of the Peoria Standpipe. A. B. Herrick. Extracts from paper by D. H. Maury are given, with the writer's views, and instances of similar deterioration before electric railways were located near. Ill. 3000 w. *St Ry Jour*—Dec. 1, 1900. No. 37984 D.

Tank.

Failure of an Elevated Wooden Water Tank by Rusting of Hoops from the Inside. Gives particulars of the failure of a tank belonging to the mills of the Bamford Bros. Silk Mfg. Co., of Paterson, N. J. Ill. 500 w. *Eng News*—Dec. 27, 1900. No. 38448.

Water Purification.

The Effect of Physical Agents on Bacterial Life. Allan Macfadyen. A lecture before the Royal Inst. of Great Britain. Gives information regarding the physical conditions favoring the presence and multiplication of bacteria, and to their destruction. 5000 w. *Pop Sci M*—Jan., 1901. No. 38284 C.

The Purification of Drinking Water by Ozone (Reinigung von Trinkwasser durch Ozon). Dr. Thomæ. A review of the processes exhibited at the Paris Exposition, with a general discussion of the

practicability of the method. 3000 w. *Zeitschr d Ver Deutscher Ing*—Dec. 8, 1900. No. 38318 D.

Water Supply.

Iron Removal from the Prenzlau Water Supply. From *Zeitschrift d. Ver Deutscher Ing*. Illustrated description of works drawing a supply from driven wells, which is aerated and filtered in Worms apparatus. An Intze water tower is another feature of the plant. 1800 w. *Eng Rec*—Dec. 15, 1900. No. 38179.

The Forbell Case. A review of a decision by the New York Court of Appeals practically forbidding the use of ground water for purposes of municipal supply, with a statement of the possibility of obtaining a reconsideration of the decree by means of data obtained from agricultural experiment stations. 1000 w. *Eng Rec*—Dec. 1, 1900. No. 37942.

I. The Latest Decision Affecting Underground Water Supplies, Borough of Brooklyn, New York City. II. British Law in Regard to Underground Water. J. Shiress Will. British law acknowledges no ownership except when in well-defined channels. New York law sustains the claim for ownership. 3800 w. *Eng News*—Dec. 6, 1900. No. 38079.

The Removal of Iron from Water. A description of small works in Germany and a review of experiments by the Massachusetts Board of Health at Watertown, Marblehead and Provincetown. 2500 w. *Eng Rec*—Dec. 29, 1900. No. 38425.

Water Supply of Greater New York. M. N. Baker. Reviews the reports of John R. Freeman, and of the Merchants' Association of New York, giving the conclusions stated in each report. 8000 w. *Munic Affairs*—Sept., 1900. No. 38291 C.

MATERIALS.

Artificial Stone.

Manufacture of Silico-Calcareous Blocks (Fabrication des Agglomérés Silico-Calcaires). H. Cuenod. A description of the Schwarz process for forming artificial stone with lime and sand under the action of vapor of water at a high temperature. 1200 w. *Génie Civil*—Dec. 1, 1900. No. 38307 D.

Brick.

Brick and Tile Works at Schernbeck, near Wesel (Thon und Falzziegelwerk der Gewerkschaft Union in Schernbeck bei Wesel). H. Seifert. With full plans of this modern plant, including pressing and molding machinery, drying and burning kilns, etc., etc. 1200 w. 1 plate. *Zeitschr d Ver Deutscher Ing*—Nov. 24, 1900. No. 38315 D.

Cement Tests.

The Practical Value of Accelerated Ce-

ment Tests. A translation of investigations by M. Gary, of the practical value of cements condemned by accelerated tests. 3500 w. Eng Rec—Dec. 8, 1900. No. 38086.

Concrete.

The Concrete Lock Near St. Paul. Description of a concrete plant of 300 yds. daily capacity, constructed on the top and slope of a bluff and operated largely by compressed air. 2100 w. Eng Rec—Dec. 22, 1900. No. 38298.

Reinforced Concrete.

A Steel-Concrete Stable Roof. Illustrated description of a 200 x 89 ft. roof having steel trusses and a covering of concrete slabs, stiffened by steel framing and wire netting. 1100 w. Eng Rec—Dec. 22, 1900. No. 38299.

The Failure of a Concrete-Steel Grain Elevator at Duluth, Minn. An illustrated description of the structure and its failure, with analysis of its cause. 500 w. Eng News—Dec. 27, 1900. No. 38445.

Rolled Joists.

See Architectural Engineering—Construction.

White Lead.

A New Process for the Manufacture of White Lead. Romyn Hitchcock. A review of processes devised for the manufacture of white lead, presenting also a new process by J. W. Bailey. 2400 w. Eng & Min Jour—Dec. 8, 1900. No. 38096.

MEASUREMENT.

Leveling.

Notes on Precision Leveling (Note sur un Niveau de Précision). MM. Boet and Huberti. Describing improvements made by the writers in the so-called "dumpy" level, and discussing methods of use. 2500 w. Rev Univ des Mines—Nov., 1900. No. 38338 H.

The Theory and Practice of Precise Spirit Leveling. Discussion of the paper by David A. Molitor. Ill. 26000 w. Pro Am Soc of Civ Engs—Nov., 1900. No. 37981 E.

Maps.

Behsel's Plan of Vienna (Der Behsel'sche Plan von Wien). S. Wellisch. An examination of the map of Vienna made in 1824, compared with existing landmarks. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 16, 1900. No. 38310 B.

The Determination of the Accuracy of a Map (Die Genauigkeitsbestimmung eines Planes). S. Wellisch. Showing the method of determining the true scale of a map, also the mean error. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 30, 1900. No. 38313 B.

Mine Surveying.

See Mining and Metallurgy. Mining.

Surveying.

History of Solar Surveying Instruments. J. B. Davis. Prepared to supplement paper by Dunbar D. Scott, on "Evolution of Mine-Surveying Instruments." Remarks on land surveys in general, and detailed history of solar instruments. Ill. 6000 w. Trans Am Inst of Min Engs—Aug., 1900. No. 38430 D.

The Adjustment of a Transit Survey as Compared with That of a Compass Survey. Charles L. Crandall. Explains the method of adjustment of a compass survey, and its improper application to transit surveying; gives a method in detail that can be used mechanically the same as the old compass survey method. 2200 w. Pro Am Soc of Civ Engs—Dec., 1900. No. 38441 E.

MUNICIPAL.

Dust Prevention.

Oil on Highways. Gives results of experiments, data on cost, and discusses advantages of its use on roadbeds, street railways and highways. 1600 w. St Ry Rev—Dec. 15, 1900. No. 38236 C.

Laboratories.

Municipal Water-Works Laboratories. George C. Whipple. Information concerning the laboratories already established and their work, and discussing the use of laboratories for other municipal needs. Ill. 4500 w. Pop Sci M—Dec., 1900. No. 37976 C.

Paris.

Paris Drainage and Water Supply. On the great sums spent on these undertakings and the unsatisfactory results. 2000 w. Engr, Lond—Dec. 14, 1900. No. 38264 A.

Pavements.

Asphaltum for a Modern Street. S. F. Peckham. Information concerning the deposits and varieties, their origin, refining, etc. Ill. 4300 w. Pop Sci M—Jan., 1901. No. 38283 C.

Automobiles and City Pavements. George E. Walsh. On the saving in wear to city pavements between heavy motor trucks equipped with broad, flat, hard rubber tires, and the ordinary horse truck with flat iron tires. 1200 w. Elec Rev, N. Y.—Dec. 26, 1900. No. 38412.

Recent Paving Practice in Lafayette, Ind. W. K. Eldridge. Describes the methods of constructing asphalt pavements, the materials used, and precautions taken. 1200 w. Munic Engng—Dec., 1900. No. 37989 C.

Sewage.

Aldershot Camp Sewage Farm. Describes a sewage farm that has been both

a success and a failure, while all the conditions remained the same excepting—the management. Ill. 5000 w. Engng—Nov. 30, 1900. No. 38110 A.

Bradford Sewage and Its Treatment. F. W. Richardson. A paper before the British Assn., describing the peculiar character of the sewage, due to the large quantities of waste liquors from woolen mills and dyeing establishments, and the methods of treatment which have been tried. 4200 w. Eng Rec—Dec. 8, 1900. No. 38087.

Purification of Sewage by Bacterial Methods. Leonard P. Kinnicut. An explanatory outline of what takes place, with a review of the methods classed under this head. Ill. Also general discussion. 10700 w. Jour N. E. Water Wks Assn—Dec., 1900. No. 38143 E.

Results Obtained with Large Experimental Septic Sewage Tanks and Rapid Filtration at Woonsocket, R. I. George A. Carpenter. Abstract of paper read before the League of American Municipalities at Charleston, S. C. 1200 w. Eng News—Dec. 20, 1900. No. 38232.

The Septic Tank Experiments of the Massachusetts State Board of Health. A review of experiments indicating that a septic tank may be a useful adjunct to filters, but that anaerobic action may be carried too far. Also describes experiments with very rapid filtration through 10½ ft. of broken stone, giving remarkable results. 2800 w. Eng Rec—Dec. 22, 1900. No. 38296.

The Treatment of London Sewage. Frank Clowes. On the advantages of bacterial treatment, giving information based on personal experiments and observation. Also discussion. 7000 w. Jour Soc of Arts—Dec. 14, 1900. No. 38404 A.

Sewers.

Building a Sewer Under a Bridge Pier. Illustrated description of the method of supporting one column of a 4-post bent of a heavy viaduct while a 16½ ft. sewer was built below it. 700 w. Eng Rec—Dec. 1, 1900. No. 37945.

Inspecting and Cleaning an Intercepting Sewer at Columbus, O. From the last annual report of Julian Griggs, Chief Engineer of the Dept. of Public Works. Describes interesting work. 1000 w. Eng News—Dec. 27, 1900. No. 38447.

The Brookfield, Mo., Sewerage System. R. P. Garrett. Illustrated description of a small system requiring some sewage

purification, but entailing the utmost economy in first cost. 1200 w. Eng Rec—Dec. 22, 1900. No. 38294.

The Ocean Outlet Sewer at Spring Lake, N. J. Illustrated description of an outfall of a sewerage system, where an earlier outfall became clogged with sand. 500 w. Eng Rec—Dec. 29, 1900. No. 38424.

Street Improvements.

How to Brighten Street Frontages. Editorial on the London street improvements, criticising the editorial opinions expressed in the *Builder*, and discussing some of the schemes. 1600 w. Jour Gas Lgt—Nov. 27, 1900. No. 38089 A.

Subways.

The City of London Subways. Illustrated description of existing subways and manner of lighting. 900 w. Elect'n, Lond—Nov. 30, 1900. No. 38108 A.

Washington, D. C.

The Monumental Grouping of Government Buildings in Washington, D. C. Extracts from a paper by E. V. Seeler, before the A. I. A., on the l'Enfant plan for the development of Washington, and the unfortunate departure from it. 2800 w. Eng Rec—Dec. 22, 1900. No. 38400.

Waste.

The Disposition of City Waste. E. R. Pritchard. Discusses the collection, sorting, sanitary and economic disposition, etc. 3400 w. Dom Engng—Dec. 20, 1900. No. 38256 C.

MISCELLANY.

Education.

The Laboratory Work of an Engineering School (Ueber Laboratoriumsarbeiten an der Bau-Ingenieurschule). Prof. Friedrich Steiner. Discussing especially the use of models for the study of framed structures. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 16, 1900. No. 38308 B.

Engineering.

Interlapping of Railway, Civil and Mechanical Engineers. Address by H. Wade Hibbard, followed by general discussion. 8400 w. Cent Ry Club—Nov., 1900. No. 38209 C.

Mr. L. F. Vernon-Harcourt on the Profession of Civil Engineering. Review of an article that appeared in the *National Review*. 2000 w. Jour Gas Lgt—Dec. 4, 1900. No. 38148 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

Cable Laying in Arctic Waters. George

H. Porter. Illustrated account of the laying of the St. Michael-Cape Nome cable and the wreck of the cable-ship. 1400 w. Elec Rev. N. Y.—Dec. 5, 1900. No. 38059.

The Action of Telegraph Signals in Long Cables (Ueber die Darstellung des Verlaufes Telegraphischer Zeichen in Langen Kabeln). Dr. F. Breisig. An examination of the course of a signal over the length of a cable, plotted graphically, taking into account the transmitting and receiving instruments. 5000 w. *Elektrotech Zeitschr*—Dec. 13, 1900. No. 38367 B.

Paris Exhibition.

Telegraphs and Telephones at the Paris Exhibition. J. Gavey. A brief review of the exhibits of this class which show novelty or illustrate the progress of the last decade. Ill. 5000 w. *Elect'n*, Lond—Nov. 23, 1900. No. 38010 A.

Rapid Telegraphy.

The Pollak-Virág Telegraph. Herr Pinter. Translation of a paper read before the Congress of Electricians at Paris. Brief illustrated description of the system, with account of recent trials and progress. 4000 w. *Engng*—Dec. 7, 1900. No. 38194 A.

Space Telegraphy.

Wireless Telegraphy. G. W. de Tunzelmann, in *Knowledge*. Illustrates and describes the apparatus of Prof. A. Popoff, and of Guglielmo Marconi. 2700 w. *Sci Am Sup*—Dec. 29, 1900. No. 38282.

Telegraphone.

The Telegraphone: A Magnetic Speech-Recorder. Valdemar Poulsen. Illustrated description of the principles and arrangement of this invention. 1600 w. *Elect'n*, Lond—Nov. 30, 1900. No. 38109 A.

Telephones.

Independent Telephone Exchange Ownership as an Investment. Burt Hubbell. Discusses the points of importance, reaching a favorable conclusion. 1500 w. *Elec Rev*, N. Y.—Dec. 12, 1900. No. 38161.

The Long-Distance Service of the Erie Telephone System. Arthur Stanley Riggs. Describes the growth of this service in the middle-western States. Ill. 3500 w. *Elec Rev*, N. Y.—Nov. 28, 1900. No. 37963.

DISTRIBUTION.

Arrangement.

The Arrangement of the Distributing Network. Charles A. Gillin. Considers the subject under the heads of 1, Uniformity of pressure; 2, Maximum variation of pressure; 3, Continuance of supply of electric energy; 4, Facility in fault localization. 3000 w. *Elec Engr*, Lond—Nov. 30, 1900. Serial. 1st part. No. 38103 A.

Distribution Systems.

See Street and Electric Tramways.

Mains.

Practical Notes on Electric Mains. Part first gives a general review, and discusses the management of men; other parts will consider cable laying and jointing, cable testing, sub-stations, house connections, street-lighting, etc. 2000 w. *Elec Engr*, Lond—Nov. 23, 1900. Serial. 1st part. No. 38015 A.

Ship Plants.

Electric Plants on Modern Warships (Die Elektrischen Anlagen Neuerer Kriegsschiffe). H. Grauert. A very full account of electrical installations on recent German warships, with diagrams of switchboards, etc. Two articles. 10000 w. *Elektrotech Zeitschr*—Nov. 22, 29, 1900. No. 38358 each B.

Small Installations.

Relative Advantages of Direct-Current and Three-Phase Distribution for Small Installations. H. A. Earle. Read before the Manchester Section of the Inst. of Elec. Engrs. Considers the choice of machinery and distribution in sub-stations and small installations; the systems are compared. 6000 w. *Elec Engr*, Lond—Nov. 30, 1900. No. 38104 A.

Switch.

A New High Voltage Cut-Out Switch (Ueber Einen Neuen Hochspannungsausschalter). J. Froitzheim. Describing a heavy apparatus using compressed air, for service in large stations. 1200 w. *Elektrotech Zeitschr*—Nov. 22, 1900. No. 38359 B.

Wiring.

Interior Wiring. Charles E. Knox. Illustrated description of the wiring of the thirty-two story Park Row building in New York City. 2000 w. *Am Elect'n*—Dec., 1900. No. 38075.

Pipes for Carrying Wires. P. I. Panamolo. Considers some points in regard to the bending of pipes used to carry wires, and the work generally. Ill. 1800 w. *W Elect'n*—Dec. 15, 1900. No. 38185.

ELECTRO-CHEMISTRY.

Batteries.

Bichromate Batteries. Alfred G. Dell. The writer's experience in the use of bichromate of potash batteries when used for induction coils. 800 w. *Elec Rev*, N. Y.—Dec. 5, 1900. No. 38060.

Bleaching.

The Haas & Oettel System of Electrical Bleaching. (Die Elektrischen Bleichapparate, System Haas & Oettel. Dr. Felix Oettel). Giving the details of the improved apparatus for the production of chlorine by the electrical decomposition of com-

mon salt, for bleaching purposes. 2500 w. *Zeitschr f Elektrochemie*—Nov. 22, 1900. No. 38538 G.

Carbide.

The Calcium Carbide Works at Milan (L'Officina pel Carbuco di Calcio di Milano). Dr. V. Lucchini. With illustrations showing the general arrangement of the works. The Gin & Leleux electric furnace is used. 2500 w. *Elettricità*—Dec. 1, 1900. No. 38351 B.

The Manufacture of Calcium Carbide. John B. C. Kershaw. Considers the efficiency and yield of carbide furnaces, and lessons derived from the study. 1200 w. *Elect'n, Lond*—Nov. 23, 1900. Serial. 1st part. No. 38009 A.

Electrodes.

The Distribution of Current on the Surface of Electrodes. (Ueber die Bestimmung der stromvertheilung auf Elektrodenflächen.) Dr. K. Norden. A paper before the German Electrochemical Society, showing the method of determining the value of electrode surface. 3000 w. *Zeitschr f Elektrochemie*—Nov. 22, 1900. No. 38537 G.

Electrolysis.

The Electrical Decomposition of Water on a Large Scale. (Ueber Elektrische Wasserzersetzung im Grossen.) Dr. O. Schmidt. A discussion of the electrolytic decomposition of water on the large scale for the commercial production of oxygen and hydrogen. 4500 w. *Zeitschr f Elektrochemie*—Nov. 15, 1900. No. 38540 G.

The Electrolysis of Fused Salts. (Demonstration zur Elektrolyse Geschmolzener Salze.) Dr. R. Lorenz. A paper read before the German Electrochemical Society, giving data of practical importance in electro-chemistry, with discussion. 4000 w. *Zeitschr f Elektrochemie*—Nov. 15, 1900. No. 38539 G.

Electromotive Force.

The Electromotive Force of Metals in Cyanide Solutions. S. B. Christy. Gives an outline of the development of the modern electro-chemical theory, an account of experimental work on the subject given, and the methods used in this investigation. 23300 w. *Trans Am Inst of Min Engs*—Sept., 1899. No. 38439 D.

Lead.

The Electrolytic Separation of Metallic Lead from Solutions, and the formation of Spongy Lead. (Die Elektrolytische Ausfällung von Metallischem Blei aus Lösungen und die Bleischwammbildung.) L. Glaser. A general discussion of methods, and an account of the author's experiments. Serial, Part I. 2500 w. *Zeitschr f Elektrochemie*—Dec. 13, 1900. No. 38542 G.

Separation.

The Electrical Separation of Metals of

the Alkalies from Fused Alkaline Chlorides. Arthur Fischer. Giving details of apparatus used in practical work. 2500 w. *Zeitschr f Elektrochemie*—Dec. 6, 1900. No. 38541 G.

ELECTRO-PHYSICS.

Alternating Currents.

Alternating Current Laboratory Experiments and Commercial Tests. Fitzhugh Townsend. A description of a series of experiments which make up the alternating current laboratory course prescribed for the fourth year students in the electrical engineering department of Columbia University. 15300 w. *Sch of Mines Quar*—Nov., 1900. No. 38288 D.

The Resistance Offered by Iron Conductors to Alternating Currents. Abstract of an article by C. Feldmann and J. Herzog, in *Elektrotechnische Zeitschrift*. A study of this subject, showing its practical importance in regard to railways worked by multiphase currents, where the rails are used as a return. 2200 w. *Elec Engr, Lond*—Nov. 23, 1900. No. 38016 A.

Magnetic Attraction.

On the Mechanical Forces in Dynamos Caused by Magnetic Attraction. B. A. Behrend. Deduces a new formula applicable to dynamos, showing its agreement with observation. 1300 w. *Trans Am Inst of Elec Engs*—Nov., 1900. No. 38286 D.

Magnetism.

Torsional Magnetostriction in Strong Transverse Fields and Allied Phenomena. C. Barus. Methods of experimenting are described and the results discussed. 4000 w. *Am Jour of Sci*—Dec., 1900. No. 37959 D.

Terrestrial Magnetism.

Action of Terrestrial Magnetism Upon a Magnetized Chronometer (Action du Champ Magnetique Terrestre sur la Marche d'un Chronometre Aimanté). A. Cornu. With especial reference to the effect of magnetism upon the chronometers of iron vessels. 2500 w. *Comptes Rendus*—Nov. 26, 1900. No. 38334 D.

Transformers.

The Action of Unloaded Transformers for Polyphase Currents (Ueber den Leerlauf von Drehstrom Transformatoren). R. Goldschmidt. An examination of the distribution in non-symmetrical transformers. 1500 w. *Elektrotech Zeitschr*—Nov. 29, 1900. No. 38361 B.

Vibrations.

Apparatus for the Detection and Registration of Electrical Vibrations. A. C. Popoff. An account of experimental investigations, with description of apparatus

used. 2200 w. Elec Rev, Lond—Nov. 23, 1900. Serial. 1st part. No. 38014 A.

GENERATING STATIONS.

Accumulator.

The Heinz Accumulator (Accumulateur Heinz). A. Bainville. Describing an improved form of Faure accumulator designed either for portable or for station service. 800 w. Electricien—Nov. 24, 1900. No. 38354 B.

Alternators.

Some Notes on the Design of Large Alternators. A. Heyland. Notes having special reference to tests made on the alternators of 1,000 E. H. P., exhibited by the Electricité et Hydraulique, Limited, of Charleroi, at the Paris Exhibition. Ill. 1700 w. Elec Rev, Lond—Dec. 7, 1900. Serial. 1st part. No. 38215 A.

Compounding.

The Compounding of Alternators (Apunti sul Compoundaggio degli Alternatori). Marco Tullio Gentile. A graphical and analytical examination, using the vector analysis of the variation limits with compounded alternators. 1800 w. Eletticità—Nov. 24, 1900. No. 38349 B.

Converters.

Rotary Converters and Motor-Generators. Frank C. Perkins. An illustrated review of the various uses to which this transforming apparatus is applied. 2200 w. W Elect'n—Dec. 8, 1900. Serial. 1st part. No. 38126.

Crewe Works.

Crewe Corporation Electricity Works. Illustrated description of a three-wire system. 3000 w. Elect'n, Lond—Dec. 7, 1900. No. 38212 A.

Dynamos.

Series Windings on Compound Dynamos and Their Adjustment. Alton D. Adams. Suggestions of value. 1100 w. Am Elect'n—Dec., 1900. No. 38074.

The Lahmeyer Dynamos at the Exposition (Les Génératrices Electriques Lahmeyer à l'Exposition). G. Leugny. Describing polyphase and continuous current dynamos exhibited at Paris by Lahmeyer, of Frankfurt, Germany. 1800 w. Revue Technique—Dec. 10, 1900. No. 38329 D.

Generating Sets.

Generating Set of 1,400 Horse Power (Groupe Electrogène de 1,400 Chevaux). A. Boudon. Illustrated description of the vertical steam engine by the Augsburg Machine Works, and direct-connected Lahmeyer alternator, exhibited at Paris. 2000 w. Génie Civil—Dec. 8, 1900. No. 38328 D.

Generating Set of the International

Electrical Company, of Liège, and the Van Den Kerchove Company, of Ghent (Groupe Electrogène de la Compagnie International d'Electricité de Liège, et de la Société Anonyme Van Den Kerchove de Gand). A 1,000 kilowatt three-phase generator and horizontal compound engine exhibited at Paris. 1000 w. Electricien—Dec. 1, 1900. No. 38356 B.

Some of the Requisites of Modern Lighting Generator Sets. H. G. Reist. Read at meeting of the Engine Builders' Assn. of the U. S. A. statement of the present situation of the steam engine in its relation to electrical generation. 2500 w. Elec Wld & Engr—Dec. 15, 1900. No. 38183.

Standardization of Direct-Connected Generating Units. A review of three papers read before the Engine Builders' Assn. of the United States, on the best methods of designing high-speed engines and generators for direct-connected units, so that the combination, as a whole, will be of the greatest efficiency. 1000 w. Eng Rec—Dec. 8, 1900. No. 38088.

The Dujardin-Schneider Generating Set (Groupe Electrogène Dujardin-Schneider). M. Ademar. Illustrated description of the 1,700 h. p. Dujardin engine, and 1,120 kilowatt Schneider alternator exhibited at Paris. 2500 w. 1 plate. Génie Civil—Nov. 24, 1900. No. 38303 D.

The Ringhoffer-Siemens & Halske Generating Set (Groupe Electrogène Ringhoffer-Siemens & Halske). G. Henry. Description of 1,000 kilowatt generating set, with Ringhoffer vertical engines and Siemens & Halske continuous-current dynamo, exhibited at Paris. 2000 w. 1 plate. Génie Civil—Dec. 1, 1900. No. 38304 D.

Isolated Plants.

Electricity at Ardross Castle. Illustrated description of a private installation of unusual interest. 3000 w. Elec Rev, Lond—Nov. 23, 1900. No. 38013 A.

Montmorency.

A Modern Canadian Water-Power Plant. An illustrated description of the Montmorency Falls generating station. 1000 w. Am Elect'n—Dec., 1900. No. 38070.

Power Station.

Central Electric Lighting and Power Station in the Brooklyn Navy Yard. Illustrated description of this plant. 1300 w. Power—Dec., 1900. No. 38190.

St. Croix Power Co.

The Plant of the St. Croix Power Co., of Wisconsin. Henry Floy. Illustrated detailed description of a long-distance transmission plant, having both hydraulic and electrical patents of more than ordinary interest. 8000 w. Trans Am Inst of Elec Eng's—Nov., 1900. No. 38285 D.

Snoqualmie Falls.

The Snoqualmie Falls Water-Power Plant and Transmission System. An illustrated detailed description of plant for developing the power of these falls in Washington. 9700 w. Eng News—Dec. 13, 1900. No. 38163.

Testing.

See Electrical Engineering, Measurement.

Three-Phase.

Three-Phase Generators at the Paris Exposition (Dreiphasen-Generatoren der "Electricité et Hydraulique" auf der Pariser Welhausstellung, 1900). A. Heyland. Describing several large alternators and examining their action by plotted curves. 3000 w. Elektrotech Zeitschr—Dec. 6, 1900. No. 38363 B.

HEATING AND WELDING.**Carbide.**

See Electro Chemistry.

Electric Furnaces.

Some Electric Furnaces for Laboratory Use. Charles L. Norton. Details of construction and operation of several small electric furnaces used in the Rogers Laboratory of Physics, for instruction and research work. Ill. 1400 w. Elec Wld & Engr—Dec. 22, 1900. No. 38239.

LIGHTING.**Arcs.**

On Rapid Variations in the Current Through the Direct-Current Arc. W. Duddell. An account of what occurs when the current is periodically varied more or less rapidly over a range which is very small compared with the mean value of the direct current. 4800 w. Elect'n, Lond—Dec. 14, 1900. Serial. 1st part. No. 38262 A.

The Hausen Arc Lamp (Lampe à Arc Hausen). Describing and illustrating three forms of improved arc lamps, for derived currents either continuous or alternating, and differential for continuous current. 1200 w. Electricien—Nov. 24, 1900. No. 38353 B.

Boston, U. S. A.

The First Electric Light Plant in Boston. Alton D. Adams. An account of a plant started Nov. 9, 1878. 1000 w. Elec Wld & Engr—Dec. 22, 1900. No. 38240.

Car Lighting.

See Railway Affairs, Motive Power.

Exposition.

Lighting at the Exposition of 1900 (L'Eclairage à l'Exposition de 1900). H. Guérin. The first of a series treating of the general lighting of the exposition describes the petroleum and alcohol incandescent lamps. Serial. Part I. 2000 w.

Génie Civil Dec. 1, 1900. No. 38067 D.

Lighting the Alexander III. Bridge. Paris. An illustrated description. 900 w. Elec Wld & Engr—Dec. 1, 1900. No. 38035.

The Luminous Decorations of the Palace of Electricity and the Chateau d'Eau (Les Décorations Lumineuses du Palais de l'Electricité et du Chateau d'Eau). With especial reference to the electric projectors and illuminated fountains at the Paris Exposition. 1200 w. Revue Technique—Nov. 25, 1900. No. 38323 D.

Incandescent.

Incandescent Lamp Development to the Year 1880. Edwin M. Hammer. Historical résumé based on records of sworn testimony in lamp litigations in the United States and abroad, and decisions of courts; and from patents, text books, published articles, etc. Ill. 3000 w. Elec Wld & Engr—Dec. 1, 1900. Serial. 1st part. No. 38037.

Nernst Lamp.

The Nernst Lamp. An illustrated description of the improved lamp, with remarks on changes made. 1700 w. Elect'n, Lond—Dec. 7, 1900. No. 38211 A.

Plant.

The Evolution of One Electric Light Plant. W. H. Wakeman. Description of the installation and subsequent changes made, giving information concerning plants appropriate for cities of 50,000 to 300,000 inhabitants. 1400 w. Am Gas Lgt Jour—Dec. 3, 1900. No. 38023.

Street Lighting.

Street Lighting by Electric Lamps. F. H. Minshall. Discusses the systems, especially those in use at Croydon, England. 4800 w. Elec Wld & Engr—Dec. 1, 1900. No. 38036.

MEASUREMENT.**Compensator.**

An Improved Compensator for the Determination of Electromotive Force (Ein Neuer Kompensator zur Bestimmung Elektromotorischer Kräfte). N. T. M. Wilshire. Describing an improved form of the Poggendorff-du Bois Reymond apparatus. 1000 w. Elektrotech Zeitschr—Nov. 29, 1900. No. 38362 B.

Efficiency Test.

The Efficiency of the Power Station and Transmission Line of the Albion Power Co. J. C. Smith. Abstract of thesis, giving a report of the test made. 1000 w. Sib Jour of Engng—Dec., 1900. No. 38188 C.

Electrometer.

Investigations Upon the Ebert-Hoffmann High Voltage Electrometer (Untersuchungen am Ebert-Hoffmanschen Hoch-

spannungselektrometer). Ch. Bäumler. Giving the method and results of a calibration of the instrument, and data for plotting curves. 1800 w. *Elektrotech Zeitschr*—Dec. 6, 1900. No. 38364 B.

Meters.

The Testing of Electric Meters at the Physical-Technical Reichsanstalt (Das Prüfungsverfahren für Gleichstrom Elektrizitäts zähler in der Physikalisch-Technischen Reichsanstalt). K. Feussner. With illustrations of the apparatus and details of the methods used for continuous current meters. 4500 w. *Elektrotech Zeitschr*—Dec. 13, 1900. No. 38365 B.

Standards.

Report of the Committee of the American Institute of Electrical Engineers on Units and Standards. Also discussion. 5000 w. *Trans Am Inst of Elec Eng*s—Nov., 1900. No. 38287 D.

Testing.

Testing Wagon for Electric Stations (Kabelmesswagen für Elektrische Zentralstationen). Illustrated description of the portable testing plant designed for use in connection with central station work by the Allgemeine Elektrizitäts-Gesellschaft. 2 articles, 3000 w. *Elektrizität*—Nov. 24, Dec. 8, 1900. No. 38352 each B.

Wheatstone Bridge.

Reversible Wheatstone Precision Bridge (Umkehrbare Wheatstone'schen Präzisions-Messbrücken). Dr. M. Th. Edelmann. Showing a simple arrangement of resistances and galvanometers, enabling measurements to be rapidly and accurately made. 1000 w. *Elektrotech Zeitschr*—Nov. 22, 1900. No. 38360 B.

POWER APPLICATIONS.

Crane.

See Mechanical Engineering, Machine Works and Foundries.

Electric Clock.

An "Electric Earth Clock" and Its Construction. N. Monroe Hopkins. Brief review of progress made in time measuring devices, with an illustrated description of the electric clock designed by the writer. 2800 w. *Sci Am Sup*—Dec. 1, 1900. No. 37953.

Electric Driving.

See Mechanical Engineering, Machine Works and Foundries.

Electric Locomotives.

Electric Locomotives. H. K. Myers. Principles which determine the size and power of locomotives necessary for various loads and grades. 2300 w. *Mines & Min*—Dec., 1900. No. 38034 C.

Electromagnets.

Lifting Electromagnets. E. B. Clark. Considers the use of electromagnets, the objections urged against them, the amount of power consumed, etc. 2800 w. *Am Elect'n*—Dec., 1900. No. 38072.

Farming.

Electricity in Farming. George E. Walsh. On the progress made, and the room for further application, especially in irrigated regions. 1300 w. *Am Elect'n*—Dec., 1900. No. 38073.

Loading.

See Marine and Naval Engineering.

Metallurgical Plant.

Electric Power and Lighting Plant at the Donetz-Jurjewka Metallurgical Works (Die Elektrische Kraftübertragungs und Beleuchtungsanlage auf den Hüttenwerken der Donetz-Jurjewka Metallurgischen Gesellschaft). Ludwig Gohs. Showing the extensive use of electric power in this large Russian works. 4500 w. *Elektrotech Zeitschr*—Dec. 13, 1900. No. 38366 B.

Propulsion.

Electric Propulsion on Canals. Editorial on the recent trials ordered by the Prussian government, on the Finow Canal. 1700 w. *Elect'n, Lond*—Nov. 23, 1900. No. 38007 A.

Regulation.

Shunt-Wound Motors on Railway Circuits. E. C. Parham. An explanation of why the belt on the motor either squeals or flies off when there is a ground-out on the line. 800 w. *Am Elect'n*—Dec., 1900. No. 38076.

Speed Regulation of Shunt Motors by the Multiple Voltage System. G. L. Hoxie. Considers the methods employed to provide for the speed adjustment, describing especially the multiple voltage system. 1500 w. *Sib Jour of Engng*—Dec., 1900. No. 38189 C.

Rock Drill.

See Mining and Metallurgy, Mining.

Smoke Prevention.

See Mechanical Engineering, Steam Engineering.

TRANSMISSION.

Long Distance.

Electric Power Transmission for 153 Miles. A statement of an experiment by the Snoqualmie Falls Power Co., made by connecting in one continuous circuit its 3-phase transmission lines between Seattle, Tacoma, and the Falls. 700 w. *Eng Rec*—Dec. 15, 1900. No. 38181.

Wisconsin.

Apple River Water Power Transmission. Walter S. Morton. Brief illus-

trated description of the plant which utilizes the power of a waterfall in Wisconsin. 600 w. Elec Wld & Engr—Dec. 8, 1900. No. 38128.

MISCELLANY.

Code.

The National Electrical Code. B. H. Glover. Read before the electrical engineering department of Armour Inst. Discusses the rules and requirements, and considers the stages through which they have passed. 2500 w. W Elect'n—Dec. 15, 1900. No. 38186.

Education.

Electrical Engineering at McGill University. Montreal, Canada. Charles T.

Child. Illustrates and describes the equipment and facilities. 5600 w. Elec Rev, N. Y.—Dec. 12, 1900. No. 38160.

Exposition.

Electrotechnics at the Paris Exposition, 1900 (Die Elektrotechnik auf der Pariser Weehausstellung, 1900). Dr. F. Vogel. A general descriptive address delivered before the German Society of Mechanical Engineers. 2500 w. Glaser's Annalen—Nov. 15, 1900. No. 38336 D.

Prices.

The 4-C Method of Charging for Electric Current. Ralph J. Patterson. Discusses methods of selling current. 1700 w. Am Elect'n—Dec., 1900. No. 38071.

GAS ENGINEERING

Acetylene.

Acetylene in Germany. Reviews the report of Dr. Rose, British Consul at Stuttgart, concerning the use of acetylene. 1800 w. Engr, Lond—Dec. 14, 1900. No. 38263 A.

Ammonia.

Ammoniacal Liquor as a Manure. G. Abbey, in the *Journal of Horticulture*. Its value and how to use it. 1300 w. Gas Eng's Mag—Nov. 10, 1900. No. 38006 A.

The Valuation of Gas Liquor. F. J. R. Carulla. Abstract of a paper read before the Soc. of Chem. Ind., England, giving a description of the method of testing ammoniacal liquor. 1800 w. Jour Gas Lgt—Dec. 4, 1900. No. 38150 A.

Carbide.

See Electrical Engineering, Electrochemistry.

Carbonic Oxide.

The Determination of Carbonic Oxide in Gas. Translated account of a new method recently described in German papers. 1300 w. Jour Gas Lgt—Dec. 11, 1900. No. 38245 A.

Combustion.

The Products of Combustion of Various Lighting Apparatus (Les Produits de Combustion de Divers Appareils d'Eclairage). N. Gréhan. Especially comparing the products of combustion of the Argand and the Welsbach burners. 1000 w. Comptes Rendus—Dec. 3, 1900. No. 38335 D.

Consumption.

Effect of Quality on the Consumption of Gas. W. J. Dibdin. Abstract of a paper and discussion at meeting of the London section of the Soc. of Chem. Ind. Reports the results of experiments made.

4800 w. Gas Wld—Dec. 8, 1900. No. 38217 A.

Mr. Dibdin on the Effect of Quality on the Consumption of Coal Gas, with Some Remarks as to the Results of Adding Water Gas to Coal Gas. Review of a paper read before the Soc. of Chem. Ind., England. 2000 w. Jour Gas Lgt—Dec. 4, 1900. No. 38149 A.

Gas Engines.

See Mechanical Engineering, Special Motors.

Gasholders.

Holders at the Birmingham Gas-Works. Describes the enlargement of a gasholder, and gives illustrations of the construction of a new holder, to be described. 1800 w. Engr, Lond—Dec. 7, 1900. Serial. 1st part. No. 38204 A.

Gas Industry.

The Future of the Gas Profession. Reviews the subject, indicating some directions in which to look for improvement. 3000 w. Jour Gas Lgt—Dec. 11, 1900. Serial. 1st part. No. 38244 A.

Gas Mixtures.

The Supply of Mixtures of Coal Gas and Water Gas. H. Bunte. Abstract translation of a communication to the German Assn. of Gas and Water Eng's. Discusses the production and distribution of a mixture of coal gas and water gas, or carburetted water gas. 6000 w. Jour Gas Lgt—Nov. 27, 1900. No. 38091 A.

Mains.

What Is the Maximum Delivering Capacity of Mains? Observations on gas distribution at high pressure and the views recently advanced by various authorities. 2000 w. Jour Gas Lgt—Dec. 4, 1900. No. 38147 A.

Meters.

Automatic Meters. Thomas Lighboy. Reviews the history of slot-meters and compares the price charged for gas consumed by slot and ordinary consumers. 2300 w. Gas Eng'g Mag—Nov. 10, 1900. No. 38005 A.

Supply.

Public Gas Supply. Alton D. Adams. Discusses the heating power of illuminating gas and makes comparison with the heating power of coal; also discusses the growing use of gas engines as a source of power, cost, etc. 1800 w. Munic Engng—Dec., 1900. No. 37987 C.

Tar and Ammonia.

Professor Lunge on Coal Tar and Am-

monia. A review of the third and enlarged edition of a work by George Lunge. 1800 w. Jour Gas Lgt—Nov. 27, 1900. No. 38090 A.

Water Gas.

Benzolized Water Gas at Erfurt. Photographic views of the plant, with plan and elevations, and description of the system of working adopted. 3000 w. Jour Gas Lgt—Dec. 4, 1900. No. 38146 A.

Welsbach.

The Welsbach Light. Report of the Franklin Inst., through its committee on Science and the Arts, on the exhibit of the Welsbach Light Co., of Gloucester City, N. J. 3000 w. Jour Fr Inst—Dec., 1900. No. 38063 D.

MARINE AND NAVAL ENGINEERING

Accident.

Smashup of the Starboard Engines of the American Liner "St. Paul." An account of the accident during the last westward trip, so far as now known. Ill. 1000 w. Marine Engng—Dec., 1900. No. 38158 C.

Battleships.

Contract Trial of the United States Battleship "Wisconsin." J. K. Robison. Illustration and description of the vessel and its equipment, with full report of the official trial. 2400 w. Jour Am Soc of Nav Engs—Nov., 1900. No. 38133 H.

Contract Trial of the United States Sea-going Battleship "Alabama." H. Hall. Illustrated detailed description of the vessel and its equipment, with report of the trial. 6500 w. Jour Am Soc of Nav Engs—Nov., 1900. No. 38130 H.

Russian First-Class Battleships—"Borodino" Class. Illustrates and describes a vessel as a type of Russia's standard battleship. 1100 w. Engr, Lond—Nov. 30, 1900. No. 38116 A.

The First-Class Battleship "Wisconsin." Brief description, with illustrations. 1200 w. Sci Am—Dec. 8, 1900. No. 38049.

Boiler Test.

See Mechanical Engineering, Steam Engineering.

Coal Consumption.

Coal-Consumption Tests of S. S. "John W. Gates." B. C. Bryan. The object of the tests described was to note the action of and results obtained using the Crowe Patent Stoker. 2500 w. Jour Am Soc of Nav Engs—Nov., 1900. No. 38132 H.

Cruisers.

Speed Trials of the "Varing." An ac-

count of the contract performance, which exceeded the requirements by $\frac{1}{4}$ knot, maintaining a speed of $23\frac{1}{4}$ knots for twelve consecutive hours, under natural draft. Ill. 1500 w. Jour Am Soc of Nav Engs—Nov., 1900. No. 38134 H.

The New Armored Cruisers of the "California" and "Maryland" Types. Illustrated description of the vessels and their equipment, with favorable comments. 1500 w. Sci Am—Dec. 1, 1900. No. 37952.

"Deutschland."

The Hamburg-American Atlantic Liner "Deutschland." A review of the progress in shipbuilding as typified by this vessel, with illustrated description of the machinery. 3000 w. Engng—Nov. 23, 1900. Serial. 1st part. No. 37994 A.

Engineers.

Naval Engineers. Editorial on the report of Rear-Admiral Melville of the United States Bureau of Steam Engineering. 2500 w. Engng—Dec. 7, 1900. No. 38193 A.

Gun.

The New American 16-inch Gun (A Propos du Nouveau Canon Américain de 16 Pouces). A discussion of the probable range of the new gun, computing its maximum to be only about 14 miles, instead of nearly 24 miles, as computed by Major Ingalls. 2000 w. Revue Technique—Nov. 25, 1900. No. 38322 D.

Lake Steamer.

New Foreign-Built Lake Steamer. Illustration, with description, of the new British-built steamship "Donnacona," constructed on the American plan and intended for service on the Great Lakes. 1200 w. Naut Gaz—Nov. 29, 1900. No. 38023.

Loading.

Electric Freight Conveyors for Loading and Unloading Vessels. Illustrated description of the McCabe electric conveyor. 600 w. Sci Am—Dec. 15, 1900. No. 38139.

Naval Proving Grounds.

United States Naval Proving Ground, Indian Head. Jos. Strauss. Illustrates and describes the grounds and the testing work. 1800 w. Sci Am—Dec. 20, 1900. No. 38280.

Propulsion.

See Electrical Engineering. Power Applications.

Shipbuilding.

Expansion of the Cramps. Statement of Charles H. Cramp concerning the plans of his company. Will probably add armor and armament to their plant. 1400 w. Marine Rev—Dec. 13, 1900. No. 38175.

The Cost of Shipbuilding in America. Editorial discussing the Subsidy Bill before the U. S. Congress. 1600 w. Engr, Lond—Dec. 14, 1900. No. 38267 A.

Shipping Bill.

Senator Frye's Speech. In the presentation of the shipping bill to the U. S. Senate. 3200 w. Marine Rev—Dec. 13, 1900. No. 38176.

Senator Hanna on the Shipping Bill. Discusses the American merchant marine and the cause of its decline, and the benefits the bill will bring to industry. 5500 w. Marine Rev—Dec. 20, 1900. No. 38410.

Subsidies for American Merchant Vessels. Editorial discussion of the ship-subsidy bill now pending in the U. S. Congress. 2500 w. Eng News—Dec. 20, 1900. No. 38230.

The Ship Subsidy Bill. States the position of the advocates of the bill, and of the opposition, and discusses its chances. 1600 w. Ir Age—Dec. 13, 1900. No. 38130.

The Ship Subsidy Bill. Considers the outlook for the measure now before the U. S. Senate. 1900 w. Ir Age—Dec. 27, 1900. No. 38275.

Steamship.

Fine New Steamship. Illustration and description of the "James S. Whitney," one of the most perfect freighters on the Atlantic Coast. 2500 w. Naut Gaz—Dec. 13, 1900. No. 38197.

Red Star Liner "Vaderland." Illustrated description of the vessel and equipment. 2400 w. Marine Rev—Dec. 27, 1900. No. 38449.

Steamship Contract.

Nicaraguan Steamship Contract. Translation of the contract between the government and Mr. Joseph Frye, representing the United States Fruit Co., of Boston, Mass., for the establishment of a line of steamers. 1800 w. U. S. Cons Repts. No. 912—Dec. 17, 1900. No. 38195 D.

Submarine.

Submarine Navigation. W. P. Bradley. An account of the development of submarine navigation, giving illustrated descriptions of vessels of particular interest, and discussing their value in coast protection and in warfare. 5700 w. Pop Sci M—Dec., 1900. No. 37975 C.

The Submarine Boat and Its Future. John P. Holland. An account of what may be expected of submarine boats in warfare and in peace. 4300 w. N Am Rev—Dec., 1900. No. 38017 D.

Tender.

Class "A" Tender of the German Navy (Dampf-Beihoot Kl. A. der Kaiserlichen Marine). Giving the lines, sections, and powering of the standard German naval tender. 2000 w. Schiffbau—Nov. 23, 1900. No. 38347 D.

Warships.

Warship Construction in 1900. Facts relating to British naval activity. 2500 w. Engng—Dec. 21, 1900. Serial. 1st part. No. 38494 A.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Accumulator.

The Lee-Coll Accumulator. Illustrated detailed account of this new accumulator for use with automobiles. 1600 w. Auto Jour—Dec., 1900. No. 38408 A.

Auto-Car Trials.

Notes on the Electric Auto Car Trial. Merwin O'Gorman. Remarks on facts developed by these trials, and information of interest. 3300 w. Elect'n, Lond—Nov. 23, 1900. No. 38008 A.

Battery Cases.

On the Construction of Battery Cases in Electric Vehicles. Translation of article by Dr. Ernst Andreas in *Centralblatt fuer Accumulatoren-und-Elementenkunde*. 2000 w. Horseless Age—Dec. 26, 1900. No. 38278.

Brakes.

Brakes. P. M. Heldt. Discusses how many to use, and how to make them effective for both directions of motion, as applied to motor vehicles. Ill. 1400 w. Horseless Age—Dec. 12, 1900. No. 38156.

Commercial Vehicles.

Commercial Automobile Vehicles. George E. Walsh. Reviews the present condition and future outlook for this class of vehicles. 1300 w. *W Elect'n*—Dec. 22, 1900. No. 38251.

Compounding.

Compounding Vehicle Gasoline Engines. C. P. Malcolm. Considers the advantages and disadvantages of a compound construction, and describes the simplest form of construction for a three-cylinder compound engine. 1600 w. *Horseless Age*—Dec. 5, 1900. No. 38092.

Dog-Cart.

The Electric Motive Power Company's Dog-Cart. Illustrates and describes the dog-cart which took part in the recent trials at Chislehurst. 1500 w. *Auto Jour*—Dec., 1900. No. 38410 A.

Driving Power.

The Driving Power. E. J. Stoddard. Mathematical. 1500 w. *Horseless Age*—Dec. 5, 1900. No. 38093.

Electric Car.

The Electric Motor-Car Problem. Reviews ideas advanced by Dr. Luxenberg, in an article in *Centralblatt für Accumulatoren und Elementenkunde*. 1400 w. *Elec Rev, Lond*—Nov. 30, 1900. No. 38102 A.

Electric Wagon.

The Pastel-Vinay Electric Wagon. Details and drawings of a vehicle constructed for the Say Sugar Refinery in Paris. 900 w. *Auto Jour*—Dec., 1900. No. 38409 A.

Exhibits.

Automobiles at the Paris Exposition (Die Weltausstellung in Paris, 1900; die Automobilen). Dr. E. Müllendorff. A general review, noting the especial features of novelty among the exhibits. 2500 w. *Glaser's Annalen*—Dec. 1, 1900. No. 38326 D.

Feed Water.

Water for Automobile Boilers. E. J. Stoddard. A discussion of the subject from the engineer's standpoint, giving tests of waters. 1200 w. *Horseless Age*—Dec. 26, 1900. No. 38277.

Gasoline Vehicle.

The Schaudel Motor Vehicle. An illustrated detailed description, from *La France Automobile*. 3200 w. *Horseless Age*—Dec. 19, 1900. No. 38223.

Gears.

Gearing. E. C. Oliver. Information concerning the systems, strength of gears, etc., intended for those interested in the design and construction of automobiles. Ill. 2400 w. *Horseless Age*—Dec. 19, 1900. No. 38222.

Heavy Traffic.

Heavy Motor Traffic in France. Georges Forestier. Address before the Liverpool Self-Propelled Traffic Assn. A general review of automobilism in France, and closely related topics. 11200 w. *Auto Jour*—Dec., 1900. No. 38411 A.

Liquid Air.

Liquid Air Automobile. Brief illustrated description of a novelty exhibited at the Automobile Show in New York. 700 w. *Sci Am*—Dec. 1, 1900. No. 37951.

Pavements.

See Civil Engineering—Municipal.

Steam Vehicles.

The Automobile Manufacturing Company's New Steam Carriage. Illustrated description of an entirely different system from any hitherto on the market, and the latest design. 3000 w. *Auto Jour*—Dec., 1900. No. 38407 A.

The Serpollet Steam Automobile. An illustrated description of this system and the mechanism employed. 1700 w. *Sci Am*—Dec. 8, 1900. No. 38048.

Traction.

Road Traction. H. S. Hele-Shaw. On past investigations of traction resistance, and the needed study of the causes of resistance for self-controlled vehicles, with suggestions. Also general discussion. Ill. 6000 w. *Jour Soc of Arts*—Dec. 7, 1900. No. 38200 A.

Wheels.

The Design of Wheels. Editorial on the importance of the wheel as an invention, and the new problems arising in the manufacture of self-propelled vehicles. 2600 w. *Eng News*—Dec. 6, 1900. No. 38080.

HYDRAULICS.**Air Chambers.**

Comparative Value of Different Arrangements of Suction Air Chambers on Pumps. F. Meriam Wheeler. An illustrated article showing the importance of properly locating a suction air chamber on a pump. 1500 w. *Trans Am Soc of Mech Engs*—Dec., 1900. No. 38208 C.

Pumps.

Notes on the Construction and Working of Pumps. Edward C. R. Marks. Part first considers certain laws and conditions applicable to the working of pumping machinery in general. Ill. 2000 w. *Prac Engr*—Dec. 7, 1900. Serial. 1st part. No. 38219 A.

Pumping Engine.

An Accident to a Faithful Servant. Illustrated description of a Cornish pumping engine in use since 1857 at the Cleveland water-works, with notes concerning its efficiency. 1500 w. *Eng Rec*—Dec. 29, 1900. No. 38420.

Tanks.

Improved Forms for Tanks (Neuere Formen für Flüssigkeitsbehälter). G. Barkhausen. With especial reference to various curved forms of bottoms for tanks, so arranged as to equilibrate opposing stresses. Two articles. 6000 w. *Zeitschr d Ver Deutscher Ing*—Nov. 24, Dec. 8, 1900. No. 38216 each D.

Turbines.

Testing the Capacity of Turbines. Edward P. Burch. Résumé of a test recently made for the St. Anthony Falls Water Power Co., of Minneapolis. 1600 w. *Elec Wld & Engr*—Dec. 22, 1900. No. 38241.

MACHINE WORKS AND FOUNDRIES.**Armstrong.**

Lord Armstrong and the Elswick Works. Benjamin Taylor. A description of the growth and present condition of the Armstrong works at Elswick as an example of successful Works Management. 3500 w. *Engineering Magazine*—Jan., 1901. No. 38368 B.

Carnegie.

The Huge Enterprises Built up by Andrew Carnegie. Chas. M. Schwab. A study of the Carnegie works as illustrative of the methods of one of the foremost industrial managers. 4000 w. *Engineering Magazine*—Jan., 1901. No. 38369 B.

Casting Machine.

The Ramsay Casting and Conveying Machine. Illustrated detailed description. 2000 w. *Ir Trd Rev*—Dec. 13, 1900. No. 38174.

Castings.

Scabs and Buckles—Their Cause and Effect. Edward B. Gilmour. Explains the terms as applied to castings, and discusses the erroneous views held and the true cause. 1000 w. *Foundry*—Dec., 1900. No. 37992.

Cost Keeping.

Cost Keeping: A Subject of Fundamental Importance. J. N. Gunn. A discussion of the fundamental principles essential to the establishment of a satisfactory system, with especial reference to engineering works. 3000 w. *Engineering Magazine*—Jan., 1901. No. 38382 B.

Crane.

Twenty Ton Electric Crane at the Paris Exposition (Der 20 Tonnen Elektrische Laufkran auf der Weltausstellung in Paris). Todor Kende. A general description of the electric crane built by Ganz & Co., of Budapest. 2000 w. *I plate. Zeitschr d Oesterr Ing u Arch Ver*—Nov. 30, 1900. No. 38312 B.

Depreciation.

The Radical Policy of Scrapping Costly Machinery. H. F. J. Porter. A striking review of the drastic methods of American managers in throwing aside costly machines so soon as improved devices appear. An exposition of the contrast between English and American methods. 4500 w. *Engineering Magazine*—Jan., 1901. No. 38386 B.

Dies.

Binding and Forming Dies for Round Work. Joseph V. Woodworth. Illustrates and describes circular binding and forming dies and the methods of using them. 900 w. *Am Mach*—Dec. 13, 1900. No. 38152.

Electric Driving..

Applications of Electric Power in Engineering Works. Dr. Louis Bell. A broad discussion of the changes wrought by the distribution of electric energy in engineering works and its influence upon the arrangement and design of establishments. 4000 w. *Engineering Magazine*—Jan., 1900. No. 38385 B.

Facing.

Developing a Manhole Facing Machine. H. P. G. Norstrand. Illustrated description of a machine designed to face off the flanges of elliptical shaped manhole openings. 800 w. *Am Mach*—Dec. 13, 1900. No. 38155.

Foundry Practice.

A Survey of Modern Foundry Practice. Percy Longmuir. Showing the defects of many of the older foundries and the remarkable cheapening in castings effected by the introduction of modern methods and machines. 5000 w. *Engineering Magazine*—Jan., 1901. No. 38379 B.

The Empress Foundry, Manchester. Illustrated description of new English works. 1500 w. *Engr, Lond*—Dec. 7, 1900. No. 38205 A.

The Westinghouse Machine Company. An illustrated detailed description of the foundry of this company, located at East Pittsburg, Pa., and the castings made there. 3000 w. *Foundry*—Dec., 1900. No. 37991.

Gearing.

Some Tricks in Spacing Gear Teeth—Spacing for Prime Numbers of Teeth by a Jack-in-the-Box Mechanism. A. L. de Leeuw. Illustrated description of methods. 2800 w. *Am Mach*—Dec. 6, 1900. No. 38067.

Hoisting.

Notes on Hoisting Drums. C. F. Blake. Illustrated suggestions concerning the design of hoisting drums. 500 w. *Am Mach*—Dec. 13, 1900. No. 38151.

Intensified Production.

Intensified Production and Its Influence Upon the Worker. M. P. Higgins. An argument to show that the use of modern automatic machinery does not act to degrade and injure the workman, but that the contrary is the real effect. 4000 w. Engineering Magazine—Jan., 1901. No. 38374 B.

Krupp.

The Founders of the Krupp Establishments. E. Schroedter. A historical review of the development of the great Krupp works, showing the results of skilled industrial management and organization. 3500 w. Engineering Magazine—Jan., 1901. No. 38370 B.

Labor Management.

Altruism and Sympathy as Factors in Works Administration. J. H. Patterson. Giving numerous examples of the manner in which the comfort and happiness of employees are considered in well-known establishments in Europe and America. 3500 w. Engineering Magazine—Jan., 1901. No. 38375 B.

Lathe.

A New Elliptical Lathe. C. W. MacCord. Illustrates and describes a lathe for elliptical turning, possessing novel features. 1800 w. Sci Am Sup—Dec. 15, 1900. No. 38141.

Machine Tools.

Machine Tools at the National Show. Illustrated description of interesting exhibits. 3400 w. Engng—Dec. 7, 1900. No. 38192 A.

Machine Tools at the Stanley Show. Illustrated description of interesting exhibits. 5000 w. Engng—Nov. 30, 1900. No. 38111 A.

Notes Taken on the Manufacture of Machine Tools at the Shops of Prentice Bros. Company, Worcester, Mass. Ill. 3500 w. Mach, N. Y.—Dec., 1900. No. 38056.

Some Continental Machine Tools. An illustrated study of these tools as presented at the Paris Exhibition. 15600 w. Engr, Lond—Nov. 23, 1900. No. 37999 A.

Milling Machines.

Milling Machine Heads at Paris. Notes certain features of design which have for their object the adaptation of the milling spindle to work at various angles. Ill. 2000 w. Engng—Dec. 21, 1900. No. 38461 A.

Molding.

Molding a Casting by Bedding in the Floor. R. H. Palmer. An illustrated description of this method and a statement of some of the advantages. 1300 w. Am Mach—Dec. 6, 1900. No. 38069.

Molding a Fly-wheel. Illustrated de-

scription of the method used. 800 w. Am Mach—Dec. 27, 1900. No. 38414.

Molding a Gas Engine Bed in a Three-Part Flask. R. H. Palmer. Illustrated description of the method used. 1200 w. Am Mach—Dec. 13, 1900. No. 38153.

Organization.

The Old Trades Unionism vs. Wisely Organized Labor. George N. Barnes. A review of the relations of employers and employees in Great Britain, by the Secretary of the Amalgamated Society of Engineers. 3500 w. Engineering Magazine—Jan., 1901. No. 38373 B.

What Employers May Prevent and Effect by United Action. Sir B. C. Browne. A discussion of the uses and abuses of organization among employers and employees from the standpoint of the Employers' Federation. 3000 w. Engineering Magazine—Jan., 1901. No. 38372 B.

Paris Exhibition.

Cast, Forged, and Flanged Work at Paris. A review of exhibits. Ill. 3200 w. Engng—Dec. 7, 1900. No. 38190 A.

Pattern Making.

Pipe Work. John M. Richardson. Illustrates examples often needed for special work which must be prepared at a minimum of time and expense, giving one way of accomplishing the result. 700 w. Am Mach—Dec. 13, 1900. No. 38154.

Petroleum Furnace.

A Convenient Petroleum Furnace. An illustrated description of an economical apparatus for ordinary forge work used by Russians. 1400 w. Am Mfr—Dec. 6, 1900. No. 38094.

Piece Work.

The Taylor Differential Piece-Rate System. Sanford E. Thompson. An exposition of the method of fixing piece rates which has proved so successful in large establishments in the United States. 5000 w. Engineering Magazine—Jan., 1901. No. 38377 B.

Pneumatic Tool.

The Boyer Long-Stroke Pneumatic Hammer. Illustrated detailed description. 2000 w. Engng—Dec. 14, 1900. No. 38269 A.

Premium Plan.

The Premium Plan of Labor Remuneration. H. M. Norris. An account of the practical working of the premium system as it exists under the immediate supervision of the writer. 4000 w. Engineering Magazine—Jan., 1901. No. 38378 B.

Repairing.

Patching a Large Hydraulic Press Table. A. F. Horton. An illustrated description of difficult repairing. 1100 w. Am Mach—Dec. 20, 1900. No. 38225.

Rivets.

The Flow of Metal Exemplified by a Rivet. George S. Hodgins. An interesting explanation of what takes place in the setting of a good tight rivet. Ill. 1700 w. *Loc Engng*—Dec., 1900. No. 37969 C.

Screw Threads.

A Couple of Mechanical Paradoxes. C. C. Stutz. Illustrates the practical application of peculiar mechanical principles in the cutting of screw threads. 1600 w. *Alach. N. Y.*—Dec., 1900. No. 38057.

Shop Arrangement.

Shop Arrangement as a Factor in Efficiency. H. F. L. Orcutt. A discussion of the design of an engineering works as a great tool, by the designer of the works of Ludwig Loewe & Co., of Berlin. 3000 w. *Engineering Magazine*—Jan., 1901. No. 38384 B.

Shot Iron.

Recovery and Use of Shot Iron. E. H. Putnam. Prepared for the Dec. meeting of the Foundrymen's Assn. Explains how success was attained in using this class of iron, and the value of the magnetic separator. 1500 w. *Ir Trd Rev*—Dec. 6, 1900. No. 38062.

Specialization.

The Mechanical and Commercial Limits of Specialization. J. Slater Lewis. An examination of the natural and artificial conditions favoring the question of specialization in manufactures, with arguments for and against it. 3500 w. *Engineering Magazine*—Jan., 1901. No. 38383 B.

Westinghouse.

George Westinghouse—Inventor, Organizer, and Director. Walter M. McFarland. Describing the methods which have so successfully built up the great and varied Westinghouse interests. 4000 w. *Engineering Magazine*—Jan., 1901. No. 38271 B.

MATERIALS OF CONSTRUCTION.**Bronzes.**

The Aluminum Bronzes. From the *Aluminum World*. Some points on the making of this material and the uses for which it is adapted. 1700 w. *Foundry*—Dec., 1900. No. 37993.

Cast Iron.

See Mining and Metallurgy. Iron and Steel.

Expanded Metal.

Expanded Metal and Some of the Uses to Which It Is Put. James S. Merritt. Describes the manufacture and the various grades, and gives many interesting uses of this material. 3700 w. *Jour Fr Inst*—Dec., 1900. No. 38065 D.

Sawing.

Lines Produced in the Sawing of Metals (Lignes Superficielles Apparaissant dans le Sciage des Métaux). Ch. Frémont. An examination of the markings of sawed metallic surfaces, with reference to other marks than those produced by the saw. 1000 w. *Comptes Rendus*—Nov. 12, 1900. No. 38333 B.

Tests.

Some Recent Tests of American Iron and Steel. J. Walter Esterline and Robert B. Treat. Tests made of a large number of samples to determine the variation in magnetic quality, with results. 1200 w. *Elec Wld & Engr*—Dec. 22, 1900. No. 38242.

POWER AND TRANSMISSION.**Brakes.**

Brakes for Electric Cranes. Information concerning recent practice in electric brakes. 3400 w. *Engr, Lond*—Nov. 30, 1900. No. 38114 A.

Compressed Air.

An Air Compressor Plant for Field Riveting. Illustrated description of a 2-stage compressor on top of a horizontal receiver, the whole carried on the same skids that support the boiler. 500 w. *Eng Rec*—Dec. 1, 1900. No. 37944.

Connecting Rod.

The Stress Produced in a Connecting Rod by Its Motion. C. H. Innes. Read before the N. E. Coast Inst. of Engs. & Shipbuilders. Shows the method of mathematically computing the stress. 1100 w. *Engs' Gaz*—Dec., 1900. No. 38106 A.

Friction.

A Theoretical and Experimental Study of the Internal Friction of Lubricants (Etude Théorique et Expérimentale sur le Frottement Médiat). N. Petroff. A paper presented before the Institute of Technology of St. Petersburg, with much valuable information on the action of lubricants. 12000 w. *Revue de Mécanique*—Nov., 1900. No. 38320 H.

Loading.

See Marine and Naval Engineering.

Power Plants.

The Great Northern Paper Company's New Mill. Illustrated description of the Millinocket Mills, having a daily capacity of 400 tons of paper; the works include a large hydraulic power plant, a steam plant, mechanical and sulphite pulp mills, and a paper-making plant. All novel arrangements and fully explained. 4700 w. *Eng Rec*—Dec. 15, 1900. No. 38178.

Shafts.

Some Reasons for Making Hollow Shafts. H. F. J. Porter. Answers to

questions relating to this subject. 1000 w. *Am Mach*—Dec. 6, 1900. No. 38068.

Transmission.

Transmission of Gas and Air Through Pipes and the Transmission of Power by Compressed Air. Frederick W. Gordon. Considers the compression, transmission and expansion. General discussion. Ill. 3400 w. *Pro Engs' Club of Phila*—Nov., 1900. No. 38020 D.

SPECIAL MOTORS.

Gas Engines.

Engines for the Utilization of Blast Furnace Gases. Considers the different types of gas motors, von Oechelhaueser's system, and compares the different systems. Ill. 4300 w. *Ir & Coal Trds Rev*—Dec. 21, 1900. No. 38454 A.

One-Horse-Power Gas Engine. George H. Johnston. Design and drawings for the construction of a small gas or gasoline engine, with explanatory notes. 1700 w. *Horseless Age*—Nov. 28, 1900. No. 37962.

Gas Engines and Electric Power Plants. Reviews the series of articles published in *Engineering* by Philip Dawson, relating to the use of gas engines in connection with electric power plants. 1100 w. *Jour Gas Lgt*—Dec. 11, 1900. Serial. 1st part. No. 38243 A.

Power-Gas and Large Gas-Engines for Central Stations. Herbert A. Humphrey. Discusses gas engines, their economy as compared with steam engines, their reliability, etc., and gives appendices containing information of interest. Ill. 9800 w. *Inst of Mech Engs*—Dec. 14, 1900. No. 38440 D.

The Oechelhaueser Blast Furnace Gas Engine. Abstract of address by A. Wagen, describing the principal features of this engine. Ill. 1500 w. *Ir Age*—Dec. 6, 1900. No. 38051.

The Use of Blast Furnace Gases in Gas Engines. Joseph W. Richards. A discussion of the great economy that may be made by applying this improvement, citing many cases, and reviewing the history of investigations made. 4500 w. *Jour Fr Inst*—Dec., 1900. No. 38064 D.

Why Compounding Gas Engines Failed. H. J. Podlesak. Reviews the attempts made to compound gas and gasoline engines. 1500 w. *Mod Mach*—Dec., 1900. No. 38052.

Lubrication.

Piston Lubrication of Internal Heat Engines. Hugh D. Meier. Considers the two distinct systems employed and the advantages of each. 2800 w. *Horseless Age*—Dec. 26, 1900. No. 38276.

STEAM ENGINEERING.

Boiler Pressure.

High vs. Low Boiler Pressure. Alfred Siebert. Advantages of low pressure for heating; the difference when used for power purposes; and the influence of cylinder condensation. 1700 w. *Ice & Refriger*—Dec., 1900. No. 38021 C.

Boiler Test.

Test of One of the Babcock & Wilcox Boilers for the "Cincinnati." Gives a description of the boiler and appurtenances and of the object of the tests and apparatus, with the results. Ill. 2000 w. *Jour Am Soc of Nav Engs*—Nov., 1900. No. 38131 H.

Calorimeter.

A New Form of Calorimeter for Measuring the Wetness of Steam. John Goodman. Read at Bradford meeting of the British Assn. Illustrates and describes an instrument designed by the author, and also the method of using it. 2000 w. *Gas Engs' Mag*—Nov. 10, 1900. No. 38004 A.

Chimney.

See Architectural Engineering—Construction.

Corrosion.

Internal Corrosion in Steam Boilers. M. P. Bonet. Presented at Paris Congress. Discusses pitting, corrosion by hydrochloric acid or chlorides, by sulphuric acid, by tannic acid, by grease, by sugar, and by mechanical action. 6300 w. *Power*—Dec., 1900. No. 38168.

Engine Builders.

Papers Read at the Annual Meeting of the Engine Builders' Association. Official abstracts of papers by H. C. Ebert, H. G. Reist, and E. J. Armstrong. 5300 w. *Eng News*—Dec. 20, 1900. No. 38227.

Feed Water.

See Mechanical Engineering, Automobilmism.

Fuels.

See Mining & Metallurgy, Coal and Coke.

Indicators.

Cut-off in Indicator Work. G. W. Wildin. Suggestions from the writer's experience in indicator work. 1400 w. *Loc Engng*—Dec., 1900. No. 37971 C.

Mechanical Draft.

The Application of Mechanical Draft to Stationary Boilers. Walter B. Snow. Presented at meeting of the N. Eng. Cotton Mfrs.' Assn. Illustrated paper dealing with cost, expense of maintenance and operation, methods of application, etc. 4000 w. *Power*—Dec., 1900. No. 38170.

Meter.

The Gehre Steam Meter (Der Dampf-messer von Gehre). L. C. Wolff. The apparatus acts by recording the difference in pressure upon two sides of a contracted passage, giving the flow at any instant and the total quantity in a given period. 2000 w. *Zeitschr d Ver Deutscher Ing*—Dec. 8, 1900. No. 38319 D.

Pipes.

Pipe Bends in the Power Plant. Illustrated discussion of the advantages of the use of bends in place of elbows. 3200 w. *Power*—Dec., 1900. No. 38171.

Powdered Coal.

Burning Powdered Coal in Stationary Boilers. Illustrated description of apparatus in a Brooklyn machine shop, with tests of its operation. 1000 w. *Eng Rec*—Dec. 29, 1900. No. 38422.

Smoke Prevention.

The Possibilities of Electrical Smoke Deposition. J. Wright. Recalls some early experiments in this direction, as given in a paper by Prof. Lodge, and offers suggestions. 1200 w. *Elec Rev*, Lond—Nov. 23, 1900. No. 38012 A.

Steam Power.

The Relation of the Steam Engine to Modern Economic Production. F. R. Hutton. A critical examination of the influence of the development of steam power upon the industrial problems of the day, with especial relation to the subject of works management. 3500 w. *Engineering Magazine*—Jan., 1901. No. 38376 B.

Tube Cleaners.

Boiler Tube Scrapers and Brushes. James F. Hobart. Brief illustrated descriptions of various types. 1200 w. *Am Elect'n*—Dec., 1900. No. 38077.

Turbines.

Steam Turbines. Francis Hodgkinson. Discusses in detail this branch of steam engineering. Ill. 8200 w. *Am Mfr*—Dec. 20, 1900. No. 38249.

MISCELLANY.**Airship.**

The Roze Dirigible Airships. Illustrated description of an interesting type being

constructed in the vicinity of Paris. 1300 w. *Sci Am*—Dec. 22, 1900. No. 38226.

Card Index.

Engineering Periodicals, and the Card Index. H. Wade Hibbard. Presented before the Cornell Soc. of Mech. Eng. On the value of trade papers and of the card index. 4700 w. *Sib Jour of Engng*—Dec., 1900. No. 38187 C.

Cold Storage.

The Cold-Storage Plant of the Brussels Markets (Frigorifère des Halles Centrales de Bruxelles). Leon Ducuroir. A full account of the ammonia refrigerating plant on the Fixary system, in successful operation at Brussels for the preservation of market material and the production of ice. 7500 w. 2 plates. *Rev Univ des Mines*—Nov., 1900. No. 38340 H.

Combinations.

The Strength and Weakness of the Combination or Trust Idea. A symposium of the opinions of Messrs. John D. Rockefeller, Andrew Carnegie, J. B. Dill, and the late Lord Russell; with editorial comments. 4500 w. *Engineering Magazine*—Jan., 1901. No. 38388 B.

Mechanical Progress.

Chronology of the Nineteenth Century. A record of mechanical progress during the past one hundred years, reviewing the important events in the development of machinery, chiefly in the United States, and to some extent in other countries. 18700 w. *Mach*, N. Y.—Dec., 1900. No. 38058.

Ordnance.

The Development of the Krupp Field Artillery Material. Illustrated notes on the material and construction of ordnance. 5800 w. *Jour U. S. Art*—Nov.-Dec., 1900. Serial. 1st part. No. 38196 D.

Paper Making.

The Paper Industry at the Exposition of 1900 (*L'Industrie du Papier à l'Exposition de 1900*). H. de la Coud. A general account of the machines for preparing the pulp, as well as those for the manufacture and finishing of paper, as shown at the Exposition. Two articles, 4000 w. *Génie Civil*—Nov. 17, 24, 1900. No. 38301 each D.

MINING AND METALLURGY**COAL AND COKE.****Australia.**

The Coalfields of Western Australia. Information from a bulletin of the Geol. Survey of W. Aust., with maps. 1600 w. *Col Guard*—Nov. 30, 1900. No. 38122 A.

Briquettes.

American Coal Briquettes. Information concerning the methods of manufacture in America as compared with European practice; the advantages, etc. 1800 w. *Sci Am*—Dec. 8, 1900. No. 38047.

Briquettes as Steam Fuel. Reviews the early attempts at making briquettes, and reports tests made with various fuels. 2200 w. Ir & Coal Trds Rev—Dec. 7, 1900. No. 38202 A.

By-Products.

By-Product Coke Ovens. George Blake-Walker. A paper contributed to the Inst. of Civ. Engs., England. Considers the attempts made to recover the products, the design of by-product coke-ovens, etc. Ill. 2300 w. Col Guard—Dec. 7, 1900. Serial. 1st part. No. 38206 A.

Coalfields.

Post-Carboniferous Coalfields. Calls attention to deposits belonging to more recent geological dates than the true carboniferous, and their economic importance. Ill. 3500 w. Col Guard—Dec. 21, 1900. Serial. 1st part. No. 38460 A.

Coal Handling.

Handling Anthracite Coal. Waldon Fawcett. Illustrates and describes the improved and economical methods now in use. 1900 w. Sci Am—Dec. 1, 1900. No. 37950.

Coal Working.

Modern Soft-Coal Mining and Handling in the United States. Henry Hale. Illustrated description of methods of mining and shipping. 1800 w. Sci Am—Dec. 15, 1900. No. 38138.

Fuels.

Relative Values of Fuels Used on the Pacific Coast. Irving C. Allen. A report of determinations made by the writer. Extract from a thesis prepared by the author. 1500 w. Min & Sci Pr—Dec. 8, 1900. No. 38159.

India.

Cheap Coal Mining in India. An account of the methods of mining, the miners and their cheap labor. 1900 w. Am Mfr—Nov. 28, 1900. No. 37956.

Modern Mining.

The Pittsburg & Buffalo Coal Company's Mines. Illustrates and describes mines, showing the great advances made in coal mining by machinery, handling the coal, haulage, etc. 2500 w. Eng & Min Jour—Dec. 22, 1900. No. 38247.

Natal.

The Coal Fields of Natal. William Taylor Heslop. Information concerning this South African coalfield, its collieries, etc. 1500 w. Am Gas Lgt Jour—Dec. 24, 1900. No. 38418.

New Sinkings.

Description of Sandwell New Sinkings. Warstone Fields, West Bromwich. H. C. Cole. Describes the pumping arrangements, boilers, sinking and hauling en-

gines, etc. Ill. 1800 w. Ir & Coal Trds Rev—Nov. 23, 1900. No. 38001 A.

Paris Exhibition.

Douchy Colliery at the Paris Exhibition. An account of the exhibits made by this colliery and of its deposit, method of working, etc. 2500 w. Col Guard—Nov. 30, 1900. No. 38123 A.

Lievin Colliery at the Paris Exhibition. An account of the exhibits made by this company, the methods of mining practiced, etc. 5300 w. Col Guard—Nov. 23, 1900. No. 38002 A.

Roche-la-Molière and Firminy Collieries at the Paris Exhibition. Description of an interesting exhibit which obtained a grand prix. 5500 w. Col Guard—Dec. 14, 1900. No. 38403 A.

Peat.

Peat and Compressed Peat Fuel. Philip R. Bjorling. Describes natural and compressed peat, methods of obtaining and preparing it, etc. 4000 w. Col Guard—Nov. 30, 1900. Serial. 1st part. No. 38119 A.

Philippines.

Coal Fields of the Philippines. G. D. Rice. Facts in regard to their location, extent, quality of the coal, and the opportunities for profitable operation. 2700 w. Mines & Min—Dec., 1900. No. 38030 C.

Sinkings.

The Sandwell Park New Sinkings. H. C. Cole. Abstract of a paper contributed to the *Journal* of the British Society of Mining Students. Descriptive account. 1500 w. Col Guard—Dec. 7, 1900. No. 38207 A.

Victoria.

The Coal Deposits of Victoria. James Stirling. An account of the discovery and extent of the coal-bearing areas, the character of the coal, etc. Ill. 3300 w. Ir & Coal Trds Rev—Nov. 23, 1900. No. 38000 A.

COPPER.

Tasmania.

Mining in Eastern Tasmania. H. Grant. Part first gives the history of the Echo Mine, yielding copper, gold and silver, but in small percentages. 1600 w. Aust-Min Stand—Oct. 25, 1900. Serial. 1st part. No. 38053 B.

GOLD AND SILVER.

Alaska.

Some Experiences in the Nome District, Alaska. Barry Searles. Reviews the rush of the season of 1900 and the resulting conditions, giving information of the region, and the degree of success. 3200 w. Eng & Min Jour—Dec. 20, 1900. No. 38450.

Australia.

The Indicator Vein, Ballarat, Australia. T. A. Rickard. An illustrated description of this peculiar black seam traversing the bed-rock underlying the alluvial deposits, and found to be associated with rich bunches of gold ore. 2800 w. *Trans Am Inst of Min Engs*—Aug., 1900. No. 38-437 D.

British Columbia.

Greenwood Mining Division, Boundary Creek District. W. M. Brewer. Information compiled from the last report of the Greenwood Board of Trade. 1500 w. *Eng & Min Jour*—Dec. 1, 1900. No. 38-038.

Bryan Mill.

The Bryan Mill as a Crusher and Amalgamator Compared with the Stamp Battery. E. A. H. Tays. Continued discussion. The writer's reply to A. H. P. Wynne's criticism. 2000 w. *Trans Am Inst of Min Engs*—Sept., 1899. No. 38-435 D.

Dredging.

A California Gold Dredger. R. H. Postlethwaite. Illustrated description of a dredger on the Feather River. 1200 w. *Min & Sci Pr*—Dec. 15, 1900. No. 38221.

Dredging for Gold. W. S. Russell. Facts in regard to the operation of dredges on placers at various places in the western part of the United States. Ill. 1800 w. *Mines & Min*—Dec., 1900. No. 38026 C.

Suggestions on Inland Gold Dredging. A. C. Eteson. Suggestions on the practical working of a dredger. Ill. 1000 w. *Min & Sci Pr*—Dec. 22, 1900. No. 38279.

Milling.

Stamp Milling of Free Gold Ores. Dana Harmon. Read before the Tech. Soc. of the Pacific Coast. A discussion of the fundamental principles of milling. Ill. 8500 w. *Min & Sci Pr*—Dec. 1, 1900. No. 38061.

The New Gold Mill at Republic, Washington. D. C. Jackling, in the *Republic Miner*. Description of the mill and arrangements for treating the ores. 1700 w. *Eng & Min Jour*—Dec. 1, 1900. No. 38-039.

Philippines.

Gold in the Philippines. F. F. Hilder. Information obtained during a recent visit to the Islands, from sources considered reliable. 2000 w. *Nat Geog Mag*—Dec., 1900. No. 38129 C.

Smelting.

Pyritic Smelting and Hot Blast. S. E. Bretherton. Considers questions relating to pyritic smelting, the ores suitable, etc. 2300 w. *Eng & Min Jour*—Dec. 29, 1900. No. 38452.

Tailings.

When to Begin Treatment of Cyanide

Tailings. Henry M. Crowther. Suggests a profitable method of retreatment when conditions are favorable. 1500 w. *Eng & Min Jour*—Dec. 22, 1900. No. 38248.

Tellurides.

Notes on Tellurides from Colorado. Charles Palache. Describes a series of sylvanite crystals, in proof of the correctness of Pearce's conclusions published in 1894. Ill. 2700 w. *Am Jour of Sci*—Dec., 1900. No. 37960 D.

Witwatersrand.

Deep-Level Shafts on the Witwatersrand, with Remarks on a Method of Working the Greatest Number of Deep-Level Mines, with the Fewest Possible Shafts. Thomas Haight Leggett. Describes the gold deposits of this region and manner of working. 9600 w. *Trans Am Inst of Min Engs*—Aug., 1900. No. 38438 D.

IRON AND STEEL.**Address.**

Sir Lowthian Bell on the Progress of the Iron Industry. Address before the Institution of Junior Engineers. 5000 w. *Ir & Coal Trds Rev*—Dec. 7, 1900. No. 38203.

Biwabik Mine.

The Biwabik Ore Mine. An illustrated summary of work accomplished in opening this iron mine of the Mesaba range, by the stripping process. 1600 w. *Ir Age*—Dec. 13, 1900. No. 38135.

Blast Furnace.

The New Blast Furnace of the Marcinelle & Couillet Company (Le Nouveau Haut-Fourneau de la Société Anonyme de Marcinelle et Couillet). J. Smeysters. An account of two fine furnaces of 16.5 meters height and 160 metric tons capacity each, recently erected in Belgium, these being among the largest and finest on the Continent. 2000 w. *Rev Univ des Mines*—Nov., 1900. No. 38339 H.

Cast Iron.

The Chemistry and Physics of Cast Iron. Continued discussion of Mr. Kreuzpointner's paper entitled "Riddles Wrought in Iron and Steel." 4200 w. *Jour Fr Inst*—Dec., 1900. No. 38066 D.

The Influence of Silicon and Sulphur on the Condition of Carbon in Cast-Iron. Henry M. Howe. A study of this subject, giving the author's results, and examining the results of other investigations. 3800 w. *Trans Am Inst of Min Engs*—Aug., 1900. No. 38433 D.

The Micro-Structure and Physical Properties of Cast-Iron, as Affected by Heat-Treatment, Especially in the Manufacture of Malleable Cast-Iron. A. T. Child and W. P. Heineken. Presents re-

sults of a series of experiments made in the metallurgical laboratory of Columbia University, New York City. Ill. 5200 w. Trans Am Inst of Min Engs—Aug., 1900. No. 38436 D.

Deposits.

Peculiar Mines and Ore Deposits. Arthur Lakes. Illustrated description of the "contact deposits" of the La Plata Mountains, Colorado, and other deposits of interest. 2200 w. Mines & Min—Dec., 1900. No. 38033 C.

Gold Deposits.

Farncomb Hill Gold Deposits. Arthur Lakes. A description of the rich and peculiar deposits near Breckenridge, Colorado, and the methods of working them. 1400 w. Mines & Min—Dec., 1900. No. 38032 C.

Hardening.

Pack Hardening of Steel. E. R. Markham. Describes the method known as pack hardening and the necessary appliances. 1700 w. Loc Engng—Dec., 1900. No. 37967 C.

Iron Mines.

The Iron-Mines of Hartville, Wyoming. H. M. Chance. Gives the general characteristics, and detailed description of the openings. 7000 w. Trans Am Inst of Min Engs—Aug., 1900. No. 38432 D.

Iron Ores.

Notes on the Fossil Iron Ores of Georgia. S. W. McCallie. Describes the deposits, their chemical composition, and methods of mining. Ill. 1700 w. Eng & Min Jour—Dec. 29, 1900. No. 38451.

Phase Theory.

The Phase Theory of Iron and Steel (Le Fer et l'Acier au Point de Vue de la Doctrine des Phases). H. W. Bakhuys Roozeboom. A very complete discussion, translated, with comments, by Prof. Osmond. 20000 w. Bull de la Soc d'Encour—Nov. 30, 1900. No. 38321 G.

Puddling.

The Chemical Phenomena of Puddling. L. Cubillo. An account of experimental researches undertaken to ascertain whether the oxidation of the metalloids and metals which occurs in the cast-iron is caused by the oxygen of the oxidizing coating of the furnace, or by the oxygen of the gases which come from the hearth. Describes the entire operation. Ill. 3200 w. Ir & Coal Trds Rev—Nov. 30, 1900. No. 38118 A.

Rails.

The Kennedy-Morrison Rail Finishing Process. Brief illustrated description. 1700 w. Ir Age—Dec. 20, 1900. No. 38224.

Separating.

The Magnetic Separation of Iron Ores (Magnetische Aufbereitung der Eisenerze). H. Smits. Describing a number of machines and plants now in operation, being a paper read before the Mining Congress at Paris. 3000 w. Stahl und Eisen—Dec. 1, 1900. No. 38332 D.

The Magnetic Separation of Iron Ores. Hermann Wedding. On the machines used to separate the ores, and the attempts made to utilize the iron dust. 1200 w. Ir & Coal Trds Rev—Dec. 7, 1900. No. 38201 A.

Slag.

The Analysis of Slags and Cinders. C. H. Jöüet. A paper intended as a guide for the analysis of the various slags and cinders from blast and reverberatory furnaces, producing pig and refined lead, copper and iron. 5800 w. Sch of Mines Quar—Nov., 1900. No. 38289 D.

Steel Exports.

The Pittsburg-St. Lawrence Route for Steel Exports. Waldon Fawcett. Discusses phases of the new steel transportation enterprise of the Carnegie Co. 1400 w. Eng & Min Jour—Dec. 22, 1900. No. 38246.

Steel Plant.

New Steel Castings Plant of the Shickle, Harrison & Howard Iron Company. Description, plan and interior views. 1500 w. R R Gaz—Dec. 7, 1900. No. 38097.

The Krieger Steel Works, Düsseldorf (Stahlwerk Krieger, Actiengesellschaft, Düsseldorf). A general description of an important works devoted to the production of steel castings. 2000 w. 1 plate. Stahl und Eisen—Dec. 1, 1900. No. 38331 D.

MINING.

Accidents.

Accidents in the Saxon Coal Mines (Die Betriebsunfälle beim Sächsischen Steinkohlenbergbau). Dr. G. Stein. With data from 1888 to 1899, showing the diminution in the number of accidents. 2500 w. Glückauf—Nov. 24, 1900. No. 38342 B.

Accounting.

Principles and Methods of Profitably Working the Mine. A. G. Charleton. A discussion of office organization, cost-keeping, and records of work done, with numerous examples from actual successful practice. 6000 w. Engineering Magazine—Jan., 1901. No. 38381 B.

Bore-Holes.

Applications of Bore-Holes in Mining. Reviews some of the applications made of bore-holes. 2000 w. Eng & Min Jour—Dec. 15, 1900. No. 38173.

new Boring Methods (Ueber Einige Neue Bohrsysteme). W. Wolski. Especially discussing the Howarth system for deep boring, in which the impact boring tool is lowered into the hole. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 1, 1900. No. 38345 B.

Electric Driving.

Economy of the Application of Electricity in Collieries and Iron and Steel Works. Ernest D. Phillips. On the improvements in the apparatus used, some of the peculiarities of the modern machines and the advantages gained by their use. Ill. 2500 w. Ir & Coal Trds Rev—Dec. 21, 1900. No. 38457 A.

Electrically-Driven Machinery in the "Adolf von Hausemann" Mine (Elektrisch Betriebene Maschinen auf der Zeche "Adolf von Hausemann"). R. Goetze. A very full description of this electric light and power plant in the Westphalia coal mining district. 3000 w. Glückauf—Dec. 8, 1900. No. 38343 B.

Electricity in Mines and Collieries. J. E. Hodgkin. Considers the extent to which electrical transmission may be adopted with profit in Great Britain. 4000 w. Ir & Coal Trds Rev—Dec. 21, 1900. No. 38458 A.

Some Recent Developments of Electrical Power in Mines. Information concerning the most up-to-date German practice in electrical applications to coal mining. Ill. 4400 w. Ir & Coal Trds Rev—Dec. 21, 1900. No. 38455 A.

Electric Haulage.

Electric Locomotives for Mine Haulage. An illustrated detailed description of an electrical locomotive for haulage purposes, with comparison of cost with mule haulage as shown by American practice. 2000 w. Ir & Coal Trds Rev—Dec. 21, 1900. No. 38459 A.

Electric Haulage for Collieries. Ernest Kilburn Scott. Reviews the systems of haulage used in the collieries of Great Britain, considering points of importance in calculating the power needed. Ill. 3800 w. Ir & Coal Trds Rev—Dec. 21, 1900. No. 38456 A.

Explosion.

Report on the Cwm Pit Explosion. Report of committee appointed to investigate the causes and circumstances of an explosion which occurred in Wales on May 14, 1900. 2000 w. Col Guard—Nov. 30, 1900. No. 38121 A.

Explosives.

Magazines for Mine Explosives. M. H. Le Chatelier. From a paper presented at the Paris Congress. Investigations of large underground depots, small underground depots, and surface depots, with conclusions from the safety standpoint.

2500 w. Col Guard—Nov. 23, 1900. No. 38002 A.

The Storage of Mining Explosives. On magazines and their advantages, considering facts enabling mine owners to decide if the consumption of explosives and available sites for magazines warrant the outlay. Ill. 3000 w. Col Guard—Nov. 30, 1900. No. 38120 A.

Faults.

The Great London Fault of the Mosquito Range and the London Mine. Arthur Lakes. An illustration of the evolution of a fault. 1600 w. Mines & Min—Dec., 1900. No. 38029 C.

First Aid.

The First-Aid Packet in Civil Practice and the Organization of First-Aid Societies. M. J. Shields. Calls attention to their value, especially in mining regions. 1300 w. Mines & Min—Dec., 1900. No. 38031 C.

Hydraulic Mining.

Notes on Hydraulic Mining. George H. Evans. Practical points necessary to be considered in carrying water in ditches, flumes, etc. Ill. 2200 w. Mines & Min—Dec., 1900. No. 38028 C.

Management.

The Practical Management of Mining Operations. John E. Hardman. A general review of the principles of successful practice in the management of mining operations. 5000 w. Engineering Magazine—Jan., 1901. No. 38380 B.

Mine Cars.

Welsh Mine Cars. J. Fox Tallis. Read before the So. Wales Inst. of Eng. An illustrated detailed description of some of the various types of cars in use in South Wales. 2000 w. Mines & Min—Dec., 1900. No. 38027 C.

Mine-Surveying.

The Evolution of Mine Surveying Instruments. Dunbar D. Scott. Continued discussion. Ill. 3800 w. Trans Am Inst of Min Eng—Dec., 1900. No. 38431 D.

Mining Laws.

Review of West Australian Mining Laws: A Comparison. George Hope. Written in the belief that helpful suggestions may be found to assist in the revision of American laws. 2100 w. Min & Sci Pr—Dec. 15, 1900. No. 38220.

Mining Problems.

Graphical Solution of Mining Problems. Leo Gluck. Describes methods and apparatus by which the labor of calculation can be materially reduced. Ill. 1600 w. Mines & Min—Dec., 1900. No. 38035 C.

Philippines.

Mining Machinery in the Philippines.

G. D. Rice. Illustrates and describes some of the native mining devices. 1000 w. Eng & Min Jour—Dec. 15, 1900. No. 38172.

Rock Drill.

A New Electric Rock Drill (Ueber eine Neue Elektrische Gesteinsbohrmaschine). R. Classen. A revolving diamond drill is driven from an electric motor by means of a flexible shaft. 2000 w. Glückauf—Nov. 24, 1900. No. 38341 B.

Safety Lamps.

Experiments on the Best Dimensions of Safety Lamp Covers (Versuche zur Ermittlung der Zweckmässigsten Abmessungen der Sicherheitslampenkörbe). H. Fändrich. Giving the results of investigations into the best proportions for the wire-gauze covers for lamps of the Davy type. 3000 w. 2 plates. Glückauf—Dec. 1, 1900. No. 38344 B.

Shafts.

Deep Shaft Sinking. J. L. C. Rae. Relates the circumstances and events which had a bearing on the work, and describes the shaft-sinking of Sydney Harbor Colliery. 4200 w. Aust Min Stand—Nov. 8, 1900. Serial. 1st part. No. 38406 B.

Wire Ropes.

Statistics of Hoisting Ropes (Statistik der Schachtförderseile). Giving data as to the life of iron and steel wire ropes in mine hoisting from data collected in Germany since 1872. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 8, 1900. No. 38346 B.

MISCELLANY.

Analysis.

The Sulphocyanides of Copper and Silver in Gravimetric Analysis. R. G. Van

Name. Describes experimental investigations. 2400 w. Am Jour of Sci—Dec., 1900. No. 37961 D.

Diamonds.

Diamonds and the Diamond Industry. W. R. Matthews. Facts concerning the diamond industry in South Africa and New South Wales, showing the many inducements to an exploitation of the latter areas. 2500 w. Aust Min Stand—Oct. 25, 1900. No. 38055 B.

Limburgite.

An Occurrence of Limburgite in the Cripple Creek District. E. A. Stevens. An illustrated description of this occurrence, with the writer's views. 1300 w. Trans Am Inst of Min Eng—Aug., 1900. No. 38434 D.

Metallurgical Plant.

See Electrical Engineering, Power Applications.

Oil Fields.

Oil and Gas Yielding Formations of California. W. L. Watts. Information from a bulletin, soon to be issued by the Mining Bureau, concerning the extent and value of these fields, their geological formation, etc. 1300 w. Min & Sci Pr—Nov. 24, 1900. Serial. 1st part. No. 37957.

The Kern River Oil-Field in California. An account of this newly-developed and productive territory. 1000 w. Eng & Min Jour—Dec. 8, 1900. No. 38095.

Quartz Reefs.

The Downward Extension of Quartz Reefs. A. W. Howitt. Read before the Victoria Chamber of Mines. A statement of the writer's opinions based on extensive study, with arguments supporting them. Ill. 3300 w. Aust Min Stand—Oct. 25, 1900. No. 38054 B.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

The Accident to the Sud Express. Charles Rous-Marten. Explains the requirements of this train, and discusses the probabilities that might furnish an explanation of the accident, giving the writer's opinion that it was due to a "wash-out." 3500 w. Engr, Lond—Nov. 23, 1900. No. 37997 A.

Discipline.

Record Discipline. Reviews the paper read by Charles Dyer before the Rocky Mountain Ry. Club, and the discussion, with editorial comment. 2800 w. R R Gaz—Dec. 21, 1900. No. 38252.

Employees.

The Discipline and Control of Railway Employees. W. H. Canniff. A review of the methods which have been found most successful in American railway management. 3500 w. Engineering Magazine—Jan., 1901. No. 38387 B.

Relief.

Railroad Employees' Relief. J. A. Anderson. An account of the origin and formation of the Relief Department of the Pennsylvania Railroad, and the results of 14 years' operation. 3000 w. R R Gaz—Dec. 21, 1900. Serial. 1st part. No. 38254.

FINANCIAL.**Valuation.**

Expert Valuation of Railway and Other Corporate Property in Michigan. Concerning the accurate valuation undertaken under the direction of the Michigan Board of State Tax Commissioners. Explains the purpose and scope of the work, and the organization of the force, etc. 9300 w. *Eng News*—Dec. 20, 1900. No. 38231.

MOTIVE POWER AND EQUIPMENT.**Air Brakes.**

Air Brake Hose Specifications. An account of foreign practice presented by J. Doyen at the International Ry. Congress. 1100 w. *Am Engr & R R Jour*—Dec., 1900. No. 38044 C.

Report of Committee on Air Brake Efficiency. Followed by discussion by members. 10700 w. *Cent Ry Club*—Nov., 1900. No. 38210 C.

Caboose.

The American Caboose Car. An illustrated detailed description of the latest standard forms of caboose cars and their construction. 5000 w. *R R Car Jour*—Dec., 1900. No. 38125.

Car Lighting.

Electric Passenger-Coach Lighting. Emerson L. Clark. Illustrates and describes the axle-driven system, claiming its advantages over the one generating unit system. 1600 w. *W Electn*—Dec. 22, 1900. No. 38250.

Coal Cars.

Coal Cars of 80,000 Pounds' Capacity. Illustrated description of cars for the Chicago, Burlington & Quincy Railroad. 600 w. *Am Engr & R R Jour*—Dec., 1900. No. 38042 C.

New 100,000-lb. Hopper Bottom Coal Cars—Norfolk & Western Railway. Drawings and information concerning new cars soon to be built. 500 w. *R R Gaz*—Nov. 30, 1900. No. 37973.

Coupling.

An Improved Coupling Appliance for Railway Wagons. Illustrated description of a recent invention by Edward Hill, of London. A most ingenious arrangement. 1600 w. *Col Guard*—Dec. 14, 1900. No. 38402 A.

Electric Locomotives.

See Electrical Engineering, Power Applications.

Fireboxes.

A Study in Locomotive Fireboxes. F. F. Gaines. A discussion of remedies for the prevention of staybolt failures in the firebox of a locomotive boiler, suggesting a possibility of discontinuing their use. Ill. 1800 w. *Am Engr & R R Jour*—Dec., 1900. No. 38043 C.

The Depth of Wide Fireboxes. Editorial giving the opinions of various correspondents, with comments. 1000 w. *Am Engr & R R Jour*—Dec., 1900. No. 38045 C.

Locomotives.

A General Examination of the Locomotives Exhibited at Paris (*Allgemeine Betrachtungen über die in Paris Ausgestellten Locomotiven*). Rolf Sanzin. A comparative study of the various engines, with respect to their national characteristics, having reference to the various loading gauges of different countries. 4000 w. *Zeitschr d Oesterr Ing u Arch Ver*—Dec. 7, 1900. No. 38314 B.

Are Six-Coupled Locomotives Necessary for Trains That Run 100 Miles or More Between Stops? General discussion by members. 9000 w. *N. Y. R R Club*—Nov. 15, 1900. No. 38157.

Express Compound Locomotive for the Kaisei Railway, Japan. Illustrated description, with dimensions. 600 w. *Engng*—Dec. 21, 1900. No. 38402 A.

Chicago & Eastern Illinois Twelve-Wheeler. Illustrated description of a very heavy compound engine. 450 w. *Loc Engng*—Dec., 1900. No. 37970 C.

Locomotives of the Madison Incline. An illustrated account of the building of the "Madison Incline" in the State of Indiana, and a study of the engines which have been used on this line. 3000 w. *Ry Age*—Dec. 7, 1900. No. 38124.

Observations Upon the Locomotives at the Exposition of 1900 (*Quelques Observations Relatives aux Locomotives à l'Exposition de 1900*). The first installment of a general review of the exhibited locomotives as illustrative of the development of the subject. Serial, Part I. 2500 w. *Revue Technique*—Dec. 10, 1900. No. 38330 D.

Saddle Tank Locomotive. Illustration, with brief description, of a locomotive recently built for a railway in South Wales. 250 w. *Engr, Lond*—Nov. 23, 1900. No. 37998 A.

Smith & Perkins' Last Type of Locomotives. C. H. Caruthers. Illustrated description. 1000 w. *Loc Engng*—Dec., 1900. No. 37968 C.

Some Foreign Four-Cylinder Compound Locomotives. Illustrations of five engines, discussing some superficial features. 1500 w. *R R Gaz*—Dec. 7, 1900. No. 38008.

Tandem Compound Express Locomotive by the Poutiloff Works, St. Petersburg (*Locomotive à Grande Vitesse "Compound Tandem" Construite par l'Usine Poutiloff à St. Petersburg*). F. Barbier. Full detailed description of 56-ton Russian engine, exhibited at Paris. 2500 w. *Génie Civil*—Dec. 8, 1900. No. 38327 D.

The Erie's Six-Wheel Switching Locomotive.

motives—Wide Fire-Box. Illustrated description. 600 w. R R Gaz—Dec. 21, 1900. No. 38253.

The First Locomotive in the Holy Land. William Crawford, Jr. Brief illustrated account of the first engine run over the road from Joppa to Jerusalem. 1000 w. Loc Engng—Dec., 1900. No. 37966 C.

The Paris Exhibition—Société Suisse, Winterthur. Illustrated descriptions of four railway locomotives and a tramway locomotive, exhibited by this firm. 1500 w. Engr, Lond—Nov. 30, 1900. No. 38115 A.

The Relative Advantages of Ordinary and Compound Locomotives. Charles Ernest Wolff. Considers compound locomotives in general, and also various types, their advantages and disadvantages, and gives conclusions reached. 4200 w. Prac Engr—Nov. 30, 1900. No. 38107 A.

The Thuile High-Speed Locomotive (Locomotive à Grande Vitesse, Système Thuile). F. Barbier. Illustrated description of the peculiar and powerful locomotive exhibited by the Creusot works at the Paris Exposition. 2000 w. 1 plate. Génie Civil—Nov. 17, 1900. No. 38300 D.

Three-Cylinder Compound Locomotive for the Jura-Simplon Railway (Locomotive Mixte Compound à Trois Cylindres des Chemins de Fer Jura Simplon). F. Barbier. Description of the engines built at Winterthur for the special Alpine service of the Jura-Simplon road, and exhibited at Paris. 1500 w. Génie Civil—Dec. 1, 1900. No. 38306 D.

Three-Cylinder Compound Locomotive for the Jura-Simplon Railway. Illustrations and description of one of sixty locomotives constructed for this railway which was exhibited at Paris. 800 w. Engng—Nov. 30, 1900. No. 38113 A.

Two-Cylinder Compound Consolidation Locomotive. Illustration and brief description of engines for the "Soo" Line. 250 w. Am Engr & R R Jour—Dec., 1900. No. 38046 C.

Railway Wagons.

Capacity of Railway Wagons as Affecting Cost of Transport. J. D. Twinberrow. Read before the Inst. of Mech. Eng. Indicates the course of railway finance during the last decade, and discusses the economies possible, especially by employing vehicles of greater earning capacity. Ill. 3800 w. Engng—Nov. 23, 1900. Serial. 1st part. No. 37996 A.

Staybolts.

Another Improvement in Staybolts. An illustrated detailed description of an important improvement devised by J. B. Barnes. 1500 w. Am Engr & R R Jour—Dec., 1900. No. 38041 C.

Trucks.

Engine Truck of the Western Railroad of France. Illustrations and description

of an interesting engine truck, with shifting center, designed for fast express locomotives. 500 w. R R Gaz—Dec. 14, 1900. No. 38167.

NEW PROJECTS.

New Line.

Great Lakes & Hudson Bay Railway. An account of the line under construction, starting at Sault Ste. Marie, and expected to require three years to complete. 500 w. U. S. Cons Repts, No. 902—Dec. 4, 1900. No. 38018 D.

PERMANENT WAY AND FIXTURES.

Culvert.

Concrete Arch Culvert, L. E. & D. R. Ry. Plans, illustrations and specifications for a culvert of 20 ft. space, recently constructed. 700 w. Ry & Engng Rev—Dec. 15, 1900. No. 38198.

Port Arthur.

The Manchurian Southern Railway and the Russian Harbor of Port Arthur (Die Süd-Mandschurische Eisenbahn und der Russische Kriegshafen Port Arthur). F. Theiss. With map and views of the harbor, showing its military advantages. 1800 w. Glaser's Annalen—Nov. 15, 1900. No. 38337 D.

Roadbed.

Practical Necessity of a Thoroughly Good Roadbed for the Fast and Economical Handling of Traffic. Michael L. Lynch. Considers the importance of location of railways, remodeling, improvements of roadbed, track, etc. General discussion. 2 plates. 2500 w. St. Louis Ry Club—Nov. 9, 1900. No. 37958.

Shops.

The New Shops of the Colorado & Southern. Ground plan, illustrations and description. 2000 w. Ry Age—Dec. 14, 1900. No. 38184.

Signals.

Automatic Train Signals (Selbstthätige Zugdeckung). A. Birk. An examination of the increasing demands for automatic block signals, in view of the reduced headway of trains, together with suggestions for improvements. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 23, 1900. No. 38311 B.

Signaling for the Pan-American Exhibition. Gives plan of the Buffalo Belt Line of the N. Y. C. R. R., and brief account of the signaling equipment. 400 w. R R Gaz—Dec. 7, 1900. No. 38099.

Station.

The Nashville Union Station. Illustrations, and general plan of yards, with description. 2800 w. Ry & Engng Rev—Dec. 22, 1900. No. 38417.

Ties.

The Preservation of Railway Ties in Europe. Discussion of paper by Octave Chanute. 6200 w. Pro Am Soc of Civ Eng—Dec., 1900. No. 38443 E.

Train-Shed.

The Peoria Train-Shed. Illustrated description of a 477 x 109-ft. train-shed, with some unusual structural features and special methods of roof illumination. 700 w. Eng Rec—Dec. 8, 1900. No. 38084.

TRAFFIC.**Freight.**

The Bessemer Heavy Traffic Freight Route. Gives a profile of the Pittsburg, Bessemer & Lake Erie, also speed diagram, with an account of the method of operation and the economical effect. 2800 w. R R Gaz—Dec. 21, 1900. No. 38255.

Rules.

Car Interchange Rules in Europe. A summary of the regulations of the principal countries. 900 w. R R Gaz—Dec. 7, 1900. No. 38100.

STREET AND ELECTRIC TRAMWAYS

Accumulators.

Traction by Accumulators (La Traction par Accumulateurs). A discussion of the report of MM. Broca and Johannet at the International Tramway Congress at Paris. 3000 w. Electricien—Dec. 15, 1900. No. 38357 B.

Barcelona.

Electric Tramways in Barcelona and Vicinity. Gives particulars regarding progress on roads under construction, and changes made from horse and steam to electric traction, etc. 700 w. U. S. Cons Repts, No. 909—Dec. 13, 1900. No. 38145 D.

British Guiana.

Electric Railway for Georgetown, Demerara. N. Swan and Norman S. Rankin. An account of a modern electric railway in British Guiana, in a city of over 60,000 inhabitants. Ill. 3000 w. St Ry Rev—Dec. 15, 1900. No. 38234 C.

Cable.

Edinburgh Cable Tramways. A statement of the present condition of affairs. The new cable lines amount to 37 miles of track, covering some 19 miles of street. 2000 w. Ry & Tram Wld—Dec. 6, 1900. No. 38274 A.

Cars.

Double-Truck Cars. N. H. Heft. Read at the Kansas City convention of the Am. St. Ry. Assn. How to construct and equip them to obtain maximum efficiency with minimum cost of maintenance. 1500 w. St Ry Jour—Dec. 1, 1900. No. 37986 D.

Congress.

The International Tramway Congress (Congrès International des Tramways). Charles Jean. An abstract of the questions and discussions at the congress held in connection with the Paris Exposition of 1900. 2500 w. Génie Civil—Nov. 17, 1900. No. 38302 D.

Construction Work.

Difficult Construction Work on the Lines of the Third Avenue Railroad Company, New York. Brief illustrated description of work at the post-office loop. 450 w. Elec Rev, N. Y.—Dec. 12, 1900. No. 38162.

Contact Rails.

Contact Rails on Manhattan Elevated. Illustrated description of rails being installed in New York, in preparation for electrical operation. 300 w. St Ry Rev—Dec. 15, 1900. No. 38235 C.

Deri System.

The Deri System of Electric Traction (Trazione Elettrica Sistema Deri). G. Oliva. Two motors are used on each car; one alternating motor receiving current from overhead wire, and one continuous current motor fed from an accumulator carried on the car. 1800 w. Elettrica—Dec. 1, 1900. No. 38350 B.

Distribution Systems.

A System of Current Distribution for Tramways (Du Système de Distribution du Courant à Adopter pour les Grandes Réseaux de Tramways). P. Van Vloten. Paper and discussion at the International Tramway Congress at Paris. Two articles. 7000 w. Electricien—Nov. 24, Dec. 1, 1900. No. 38355 each B.

Systems of Current Distribution. M. Van Vloten. Read at Paris Congress. Discusses the best method for the distribution of current for large systems of tramways, including suburban lines, susceptible of extension to long distances. 5700 w. Tram & Ry Wld—Oct. 11, 1900. No. 38137 A.

Electric Locomotives.

See Electrical Engineering. Power Applications.

Electricity vs. Steam.

Electrical Locomotives and Multiple-Driven Axles. Edward H. Tyler. Con-

cerning the circumstances that must determine which is the better system. 2200 w. *Engng*—Dec. 21, 1900. No. 38463 A.

Electric Traction on Railways (La Trazione Elettrica nelle Ferrovie). D. Civita. A general discussion as to the practicability of the introduction of electric traction on main line railways. Three articles, 6000 w. *Elettricità*—Nov. 17, 24, Dec. 8, 1900. No. 38348 each B.

On the Supersession of the Steam by the Electric Locomotive. W. Langdon. Read before the Inst. of Elec. Engrs. Considers the question to be mainly a matter of economy. 3000 w. *Elec Engr*, Lond—Nov. 30, 1900. Serial. 1st part. No. 38105 A.

The Electrical Working of Main Line Railways. Ernest Kilburn Scott. A discussion of paper by W. Langdon, on "The Supersession of the Steam by the Electric Locomotive," read before the Inst. of Elec. Engrs., England. 1600 w. *Elec Rev*, Lond—Dec. 7, 1900. No. 38216 A.

Main Line Electric Traction. An account of the opening of an electric road between Albany and Hudson, in New York State. 1400 w. *Elec Rev*, N. Y.—Nov. 28, 1900. No. 37965.

The Albany & Hudson Third Rail Road. Illustrates and describes a long third-rail line recently opened. 2000 w. *Elec Wld & Engr*—Dec. 8, 1900. No. 38127.

Electrolysis.

Electric Traction Troubles. Discusses the troubles arising from electrolysis since the introduction of electric traction in England. 1400 w. *Nature*—Nov. 22, 1900. No. 38003 A.

French Tramways.

The Construction of Tramways in France. H. Conradi. A comparison between the different methods of traction based on the first cost, deducting from this what are the economical conditions under which one or other system is most suitable. 2700 w. *Ry & Tram Wld*—Dec. 6, 1900. No. 38273 A.

Gradient Railway.

The Malford Gradient Railway. Brief illustrated description of a novel suspension railway utilizing the laws of gravity. 1200 w. *Sci Am*—Dec. 29, 1900. No. 38281.

Hudson River Line.

The New Jersey & Hudson River Railway & Ferry Co. An illustrated description of the Fort Lee ferry, and the line to Englewood and Hackensack, N. J. 1800 w. *St Ry Rev*—Dec. 15, 1900. No. 38233 C.

Leeds.

Leeds Tramway Plant. Illustrated description of the horizontal cross compound engines used in this English plant. 1800

w. *Engr*, Lond—Dec. 14, 1900. No. 38266 A.

Moving Sidewalk.

Operating Data of the Moving Sidewalk and Electric Railway at the Paris Exposition. Diagrams showing power supplied to the electric railroad and to the moving platform, with comments. 900 w. *Elec Wld & Engr*—Dec. 15, 1900. No. 38182.

N. Y. Elevated

Electric Traction Equipment of the Manhattan Elevated—New York City. Discusses the changes to be made, and their advantages. Also editorial. 2700 w. *R R Gaz*—Nov. 30, 1900. No. 37974.

Electric Traction on the New York Elevated Railways. An account of the first trips of electric motor trains over the Manhattan Railway Co.'s elevated structure in Second avenue, New York City, with editorial. Ill. 2000 w. *Elec Rev*, N. Y.—Nov. 28, 1900. No. 37964.

Norwich, Eng.

Norwich Electric Tramways. Illustrated detailed description. 3300 w. *Tram & Ry Wld*—Dec. 6, 1900. No. 38270 A.

Permanent Way.

Permanent Way for Electric Traction. H. Ross Hooper. Shows the importance of permanent way to the success of electric traction, discussing materials and construction. 3000 w. *Ry & Tram Wld*—Dec. 6, 1900. No. 38271 A.

Philippines.

The Frolley in the Philippines. Discusses its outlook as a field for electric railway promoters. 2500 w. *St Ry Rev*—Dec. 15, 1900. No. 38237 C.

Polyphase.

Polyphase Electric Traction. C. A. Carus-Wilson. Discusses some features of the polyphase system, particularly those relating to punctuality and frequency of train service. Ill. 2400 w. *Elec Engr*, Lond—Dec. 7, 1900. Serial, 1st part. No. 38214 A.

Repair Shops.

The Repair Shops of the Brooklyn Rapid Transit Company. Illustrated description of shops, showing the most complete modern methods of systematically handling street-railway repairs. 2200 w. *St Ry Jour*—Dec. 1, 1900. No. 37983 D.

Sicily.

Electric Railway Possibilities in Sicily. Cesare Pio. An account of the schemes for electric traction developing in this island, where no tramways have ever been laid. 1300 w. *St Ry Jour*—Dec. 1, 1900. No. 37985 D.

Storage Batteries.

Storage Batteries in Railway Power

Stations. H. H. Morris. Read before the N. Y. State Ry. Assn. Considers the uses and advantages, and describes the Buffalo plant and the tests made, discussing the results. 4500 w. St Ry Rev—Dec. 15, 1900. No. 38238 C.

Subways.

Rapid Transit Subways in Metropolitan Cities. Illustrated account of the subways of London, Paris, Budapest, Glasgow and Boston. 5000 w. Munic Affairs—Sept., 1900. No. 38290 C.

Suspended Railway.

The Barmen-Vohwinkel Suspended Railway. Illustrates and describes details of this railway as given in a series of articles in the *Centralblatt der Bauverwaltung*. 1400 w. Elec Engr, Lond—Dec. 14, 1900. No. 38405 A.

Underground Railway.

The Metropolitan Underground Railway of Paris, France. An illustrated de-

scription of the contemplated system and of the work already done, prepared from a paper by Raymond Godfernaux, in the *Revue Generale des Chemins de Fer*. 3700 w. Eng News—Dec. 6, 1900. No. 38082.

The Underground Electric Railways of London. Gives the main points in the prospectus of the Baker Street & Waterloo Railway Co. and a general view of what is being done in the way of underground electric railways. Map. 3000 w. Ry & Tram Wld—Dec. 6, 1900. No. 38272 A.

Wannsee.

Electric Traction on the Wannsee Railway (*Elektrische Zugförderung auf der Wannseebahn*). H. Bork. A paper read before the Railway Society at Berlin, giving full details of the construction and operation, with discussion. 6000 w. Glaser's Annalen—Dec. 1, 1900. No. 38325 D.

NEW BOOKS

COMPOUND ENGINES. By F. R. Low. New York: Power Publishing Co. A series of elementary papers upon the theory of compound engines, well adapted for the instruction of the engine driver and operator.

MACHINES MARINS. By L. E. Bertin. Paris: E. Bernard & Cie. The portion of the course in steam engineering of the Ecole du Génie Maritime relating to marine engines, forming undoubtedly the most complete and recent treatise upon the subject in the French language. The work forms a worthy companion to M. Bertin's treatise on marine boilers, the two books covering the subject of marine motive power very fully, especially as representing the present state of the art in France.

LES BATEAUX SOUS-MARINS. Vol. I. Historique. Vol. II. Technologie. By MM. F. Forest and H. Noalhat. Paris: Vve. Ch. Dunod. Undoubtedly the most exhaustive treatise upon the absorbing subject of submarine navigation which has yet appeared in any language. The experiments of all the leading investigators are given, and the details of the latest constructions upon which engineers are now working in Europe and America, with numerous illustrations.

DIE PRAKTISCHEN BEZIEHUNGEN DER KINEMATIC ZU GEOMETRIE UND MECHANIK. By Prof. Dr. F. Reuleaux. Braunschweig: Frederick Vieweg und Sohn. London: Williams & Norgate. This important volume forms the second and concluding portion of Professor Reuleaux's great work, of which the first, the "Theoretical Kinematics," was given to the world more than twenty-five years ago. In this book are given the methods of applying to practical work the ingenious notation of the earlier volume, enabling a problem to be analyzed and the practical solution determined according to the theoretical methods of the distinguished author.

THE RECLAMATION OF LAND FROM TIDAL WATERS. By Alexander Beazeley, M. Inst. C. E. London: Crosby, Lockwood & Co. A handbook for engineers, landed proprietors and other interested in the reclamation of land, including the construction of the bank, the method of drainage, and the

best methods of cultivating the reclaimed area, together with an examination of the legal questions involved.

TECHNISCHE MECHANIK. Ein Lehrbuch der Statik und Dynamik. By Ed. Autenreith. Berlin: Julius Springer. A thoroughly modern treatment of the principles of theoretical mechanics, with especial reference to the applications of modern technology in the domain of the civil and mechanical engineer.

MOULDER'S TEXT-BOOK. By Thomas D. West. New York: John Wiley & Sons. London: Chapman & Hall, Limited. This work forms Part II. of "American Foundry Practice," and is devoted to a discussion of methods for obtaining good castings, and problems in difficult moulding, together with an examination of the subject of cupola construction, and the melting of iron and scrap steel in iron foundries.

THEORY AND CALCULATION OF ALTERNATING CURRENT PHENOMENA. By Charles Proteus Steinmetz, with the assistance of Ernst J. Berg. Third edition, revised and enlarged. New York: *Electrical World and Engineer*, Incorporated. A new and revised edition of Mr. Steinmetz's very full treatise of the phenomena of alternating electric currents, in which graphical and algebraic methods are freely used, the vector analysis being introduced, and the symbolic representation of general alternating waves.

FIELD FORTIFICATIONS. By G. J. Fieberger. New York: John Wiley & Sons. London: Chapman & Hall, Limited. The text book used in the course of instruction at the United States Military Academy at West Point, with examples taken from field operations in the Russo-Turkish War of 1878, and of the Franco-Prussian War of 1870.

KRAFTMASCHINEN DES KLEINGEWERBES. By J. O. Knoke. Berlin: Julius Springer. An exhaustive reviews of small motors, including hydraulic motors, hot-air engines, and the various forms of internal combustion motors. Gas engines are discussed at length, as are also the different forms of benzine and petroleum motors, both for stationary and automobile service, and a chapter is given to small steam engines.



VOL. XX.

MARCH, 1901.

No. 6.

THE COMING INDUSTRIAL EMPIRE OF PUGET SOUND.

By D. B. Bogle.

One of the most significant situations in the modern world is to be found on the northwest coast of North America. Vast deposits of iron and coal are just being developed by tireless Anglo-Saxon enterprise. Across the Pacific the enormous markets of the East are newly opened up. Wherever such conditions have existed, foci of industry have been created. Mr. Bogle sketches with authority and with admirable moderation the future promise of the cities of Pacific North America.—THE EDITORS.



On estimate of the possibilities of development in every portion of the Pacific Coast of North America would be possible. It will be found, however, that from the point of view of industrial and commercial development the Pacific Coast is not indeed narrowed to, but is centralised in, a particular portion of it known generally as the Pacific Northwest. That term itself is one which requires some definition. It denotes a territory quite well-recognised as to its centre or nucleus, but not by any means so well-defined as to its boundaries. Its centre may be taken as that point on the Pacific Coast which represents the nearest economic shipping point to the Orient. This covers the southern portion of Vancouver Island, the coast of British Columbia on the Gulf of Georgia, and the seaboard of the United States on Puget Sound. The eastern boundary may be taken

Copyright, 1900, by John R. Dunlap.

by continuing the eastern boundary of British Columbia southwards. This boundary, the watershed of the Rocky Mountains, is a natural boundary which really defines a territory differing in natural conditions from that adjoining it, and is not, like the dividing lines of the several states, or the 49th parallel itself, a mere conventional delimitation of territory. As to its northern and southern boundaries, they must be left still more indeterminate. To the south there exists somewhere a thermal line of enervation. Towards the north, on the other hand, the limits are set, not by the softness of nature, but by her rigors. In the light of recent discoveries it is necessary to speak respectfully of the frozen north. The Sunny South, indeed, levies a tribute on man's weakness by its continual invitation to a life of indolence and repose; but the north exacts too much from his strength, and browbeats his capacity to a level of uniformity with its own barren savagery and leaden gloom. All of which may be more shortly expressed by saying that the completest development, industrial and social, is only to be expected within the limits of the temperate zone.

When the development of a new country is considered, there are clearly different stages of development, at any one of which growth may be permanently arrested if the conditions are unfavourable for further evolution.

First comes what is known as the exploitation of its natural resources. Many parts of the world remain at this stage of development. They export raw material in order that they may purchase the finished products they require. Such parts of the world must always remain at the bottom of the scale. The whole course of American and Canadian progress has been a struggle to escape from this condition. It is quite possible that the eastern portions of both countries would view with equanimity the permanent condemnation of the west to this industrially subservient condition. But the same character of enterprise which has developed the industries of the eastern seaboard is reproduced upon the Pacific, and it will accomplish similar ultimate results.

The next important stage in development is the establishment of centres of distribution, where the raw produce of a country is collected and exchanged for the finished goods it consumes, instead of being drawn away direct from the separate places in which it is produced. Properly speaking, this is the function of that class of the community known as merchants. Mercantile communities are divided into two classes, those which provide a market for the raw home products, and import what is needed for the home population; and those which pro-

vide a market for the raw products of foreign countries, and supply them with what they require in exchange, whether of home production or derived from abroad. With this explanation, what is meant by the statement that the distributing centres for the Pacific Coast are, as yet, foreign points will be understood. The eastern nuclei of collection and distribution do more business in one week with the territory under consideration than the cities on the coast do in one year. The reason for this is that the territory needs nothing that comes from the Pacific Coast (whereas everything it does need comes from the eastern States) and produces nothing for which a market exists on the Pacific Coast. This fact will be found to have a most important bearing upon its future. There are exceptions, of course.

The next stage in a country's development is marked by the manufacture of the raw material produced in the country itself to supply the wants of its own population. But no country can remain very long in that condition provided it possesses any outlet at all. It must inevitably begin to supply the necessities of its less advanced neighbours; and lest it should stop short upon their necessities, will create in them various desires in order to satisfy them. It will buy their raw material and supply them with its manufactures, charging a high percentage on the value of the raw goods it purchases, which goes to remunerate its labour, increase its population, and add to its redundant stores of capital. Following upon that comes the financial control of its commercial tributaries, and the mortgaging of their natural instruments of production. But these three last stages are really one. There is no possibility of halting between one and the other of them, unless, indeed, a country by complete isolation is forced to remain at the first. In such a case it is assumed that the country has never had a market for its exports of raw material. Any country having an export trade in raw materials, and having reached the stage of manufacturing, must inevitably pass to the final stages of annexing the trade of commercially subservient territories and of possessing itself of financial domination over them. The limits of its greatness will be the limits of the territory it is thus able to control.

Certain facts may now be stated affecting the future of the Pacific Coast. The first of these is, that however rich it may be in natural resources the exploitation of these will never support a very large population, or build up great cities, so long as all the raw wealth produced is exported and all the finished products required are imported. The second of these facts is, that while a great trade may be built up

by way of the Pacific Coast with foreign countries, that of itself will not build up great cities on the coast, because modern commercial methods will prevent these cities being the sellers, purchasers, and changers of this commerce, and leave them in the condition of onlookers merely. Consequently, the future of the Pacific Coast, if it is to have any worthy of the name, is dependent on the manufacture of the raw materials produced within its limits and drawn from outside, to supply the wants of its own population and those of the available foreign territory. In other words, the Pacific Coast must have such a future as is connected with the history of the industrial, commercial, and financial supremacy of Great Britain during the nineteenth century, such a future as is visibly dawning for the United States, with its centre on the Atlantic seaboard, during the twentieth century—or it must remain forever in a condition of commercial subserviency. It must undergo a development co-ordinate with that of the Atlantic seaboard, although postponed to it in the matter of time, and deriving its dynamic force from a more or less separate commercial impulse.

This, then, must be the character of the development which will mark the future of the Pacific Coast; its extent depends upon conditions of a different nature. The first of these is the extent and variety of its natural wealth. It is quite true, as has been shown above, that no matter how rich and varied the resources of a country are, these of themselves will not give it a position of industrial or commercial supremacy, other conditions being absent; but it is equally true that no country can in this modern age attain to great commercial and industrial eminence unless it contains a great wealth of natural resources in itself, which, together with the extent of tributary territory it commands, will be the ultimate measure of its expansion.

After the extent and variety of natural resources, follow the possibilities of manufacturing finished products out of raw material at a maximum of economy compared with other manufacturing countries. Various questions are here raised. The transportation of raw material to an economic centre, the proximity of iron ore and coal, the availability of power, and the efficiency and cost of labour, are all most vitally important considerations.

Lastly, must come under review the nature and extent of the market it is proposed to supply, the wants it possesses at present, and those likely to be brought into being, as well as the goods it is able to give in exchange for what it purchases, and the availability of these goods to supply the wants of the manufacturing country or to be utilised by it in exchange with countries which can supply these wants.

It is evident that an enquiry into any one of these three conditions would extend far beyond any reasonable limits and that to exhaust all three in their bearing upon one another would be a futile task, because the future of the Pacific Coast would have become its past before the labour was completed. It is possible only to indicate in the barest way the extent to which those conditions, discovered to be necessary to a great commercial development, actually exist.

To begin with the natural resources of the Pacific Slope, these may be taken for granted. It is frequently said that this territory is not an agricultural country, except in portions of it which, relative to the whole, are insignificant. In the minds of those who say so the term agricultural is used, unconsciously, as describing a territory whose only resources are agricultural. In this sense, indeed, the Pacific Coast is not an agricultural country. It possesses plenty of agricultural land, but cannot, except in a few places, enter into competition with the prairies as an exporter of agricultural produce. Agriculture waits upon industry and population to provide an adjacent market; it does not call them into being. The salmon fisheries of the Pacific Coast are already the foundation of an important industry; its deep-sea fisheries, particularly in the more northern latitudes, are wonderfully rich and varied, but are not yet exploited to any large extent. Agriculture and fisheries are, however, unimportant to the present enquiry compared with the resources of the forest and the mine. It is beyond the limit of any merely human descriptive powers to do justice to the timber wealth of the Pacific Coast. It has been calculated with reference to British Columbia alone that at the present rate of consumption it would take 700 years to exhaust the more available supplies of timber; and as, under the husbandry of nature, forests will renew themselves in less time than 700 years, the calculation is merely a way of indicating that the timber resources of the Pacific Coast are practically inexhaustible. It is not too much to say, then, that for all trade and commerce into which wood and the products of wood enter, and for all manufactures in which wood and the products of wood are consumed, the Pacific Coast possesses resources incalculably greater than any other portion of the globe, civilised or uncivilised.

As regards the products of the mine, the territory under consideration already produces no inconsiderable proportion of the world's annual supply of gold, silver, copper, and lead. It is besides infinitely rich in iron, coal, and petroleum, of which its stores are hardly yet comprehended, much less utilised. And what is known of all its

mineral resources is as nothing in comparison with what is not known, or at most, merely indicated. An insignificant portion of the State of Idaho, for instance, produces one-third of the lead output of the United States; an inappreciable dot on the surface of British Columbia produces more lead annually than is consumed by the whole population and manufacturers of the Dominion of Canada. Copper is distributed over the whole area of the Pacific Slope. But it takes more capital, more elaborate transportation facilities, and more time to make copper mining pay than many people imagine, and consequently the area of production widens more slowly than that of gold, silver, or even lead, which, in less favoured districts, is frequently won in considerable quantities as a bye-product of silver. As for coal and petroleum, the latter has only begun to be looked for, the other is valueless unless on a line of railway or close to the seashore. Nor would a line of railway to a coal field be dreamt of unless there were a particular use for the fuel at the other end of the line. Iron ore is known to exist in almost limitless quantities, and that is all that is known about it. It awaits an available market for the products of iron, or, it would be more correct to say, the possibility of manufacturing these products in competition with other parts of the world. In two metals only is this territory deficient—nickel and tin; the latter disability it shares with the whole of North America, the former with all of it except the Canadian province of Ontario.

The iron resources of the Pacific Coast naturally introduce the question of the possibility of competition in manufactures with other parts of the world. So far as natural conditions for the manufactures of iron go, they could not be improved upon. One of the largest and most valuable known deposits of iron in this whole region exists on an island, and, dipping under the sea, reappears on the mainland adjacent to the seashore. At the most important coal mines the bunkers of ships are filled from the pit mouth. The requisites for economical reduction could not be more amply fulfilled. And, in addition, no metals except tin and nickel, which enter into the simplest as well as the most complex manufacture of iron, but are produced within the limits of the territory under consideration, and are produceable there in larger quantities (and therefore ultimately at less cost) than anywhere else. Another point, which is of great importance, has seldom had drawn to it the attention it deserves. Anyone who will take the trouble to examine a contour of the North American continent, delineated from east to west, will observe a gradual elevation from plateau to plateau to the great watershed of the Cordilleran range, and

then a series of swift and steep declensions until the water line of the Pacific Ocean is arrived at. The same excessive humidity which has clothed the Pacific Slope in the temperate zone with inexhaustible forests, makes those mountain ranges vast reservoirs of water, of which the overplus plunges down in a thousand cataracts to the sea, forming an available source of power unexcelled, and probably not even approached, in any portion of the world. In all this territory it would not only be unnecessary—it would be almost impossible—to establish any manufacturing industry beyond the radial limit of electrical energy generated by water.

The question is immediately raised: If all these things are so, why is it that the Pacific Coast in its northwestern centre is not already the manufacturing centre of the world? I suppose this question could be answered by a minute investigation into these laws of commercial and industrial relations which are at once the fascination and despair of economic thinkers—elusive as are the laws of growth and of the influence of environment upon potential development, to the biologist. It is shorter, easier, and ultimately just as satisfactory to recognise that an egg is not a chicken, and that an acorn is not an oak. At the same time, there are certain considerations, plainly to be discerned on the surface of things as it were, which indicate that industry does not spring forth like a fully armed goddess, but is developed by a series of movements infinitely minute. A further consideration is that any finished product of the more complex manufactures requires, as raw material, a multiplicity of things which are, in reference to the raw materials out of which they are constructed, themselves the completion of a manufacturing process or of many such processes. The calling together of all these industries at once cannot be conceived of, let alone accomplished. Long years of patient development are required before the action and reaction of market and opportunity admit of their consummation in a lucrative and fully developed trade. Most important of all, the labour cost of any article of manufacture is greater in the west than in the east. This difficulty in competitive production, if it may be so called, has been overcome in very many branches of manufacture in the United States, first, by the increased intelligence and therefore increased productivity naturally developed in more highly paid labour, and second, by the enforced application of genius to the invention of labour-saving contrivances. So that, while the remuneration of labour is greater, the labour cost of manufactures is not greater; in fact, through the superior natural resources of the country, and those causes affecting labour already mentioned, the total

cost of manufactures is in many cases reduced. It may be most reasonably asked why it is that the price of labour is higher in the west than in the east, when population is left perfectly free to move from the one to the other, just as indeed population is practically free to move from Europe to America. The reason is that a new country is only able to absorb population gradually as its resources are opened up; so that, while it offers greater opportunities to the individual who can gain a footing in it, to the mass it offers neither wealth which it is in their power to exploit nor a market in which they can sell their labour. Later on, when this disability has been removed, the disparity is fixed by the higher productivity and intelligence of the labour developed in the newer and richer country. This is the explanation of the fact, often commented on, that the American mechanic does a better day's work than his European brother. Nor must it be forgotten that the enhanced opportunities offered by a new country are purchased by a corresponding amount of hardship, and loss of what may be called the communal enjoyments of civilisation. How largely these bulk in human life let those judge who have been condemned for longer or shorter periods to forego them.

Whether or not there will be a permanently higher rate of remuneration for labour in the west of America than there is in the east, one thing is certain—that the industrial and commercial development of the Pacific Coast is postponed until the labour cost of the articles produced is as low as, or lower than, it is in other parts of the world. Or, it would be more correct to say, since such development is brought about by infinitesimal progressive steps, that its full equality or superiority is so postponed. The first products in which the Pacific Coast will gain pre-eminence will be those separated from the bare raw material by the simplest manufacturing process. In these products the labour cost bears a smaller relation to their value than in more complicated manufactures, and they do not require so many coincidentally developed and converging lines of raw material. Thus, one of the first trades naturally developed would be that in lumber, for which there is a good market in the commercial territory tributary to the Pacific Coast. Following lumber will come in time (not far distant) wood-pulp newspaper and indurated-paper ware, wherein lie the possibilities of a great manufacturing industry. One would naturally expect the manufacture of lead in its various forms, refined copper, and pig iron to become profitable industries at an early stage. But there is no market for these products in the territory open to the Pacific Coast. To the manufacturer they are raw materials of the

crudest kind. Consequently their manufacture in the west is simply governed by the consideration whether the comparative cost of eliminating waste material is greater than the cost of transporting that waste material from west to east. Manufactures based on such a condition do not raise a country out of the category of exporting raw material. Silver, as has already been pointed out, is in a different position. Copper and lead in the form of copper matte and lead in the form of lead bullion pay to ship east, but pig iron (much less iron ore) does not. Therefore the iron resources of this territory must lie dormant until iron can be turned into steel rails and more complex manufactures for which, under the heads of machinery and notions, North America finds a good and growing market in the Orient.

The commercial territory available to the Pacific Coast is of vast extent, wide as the periphery of the Pacific Ocean. It contains population, resources, and possibilities of fruitful commercial intercourse greatly in excess of those represented by European and Atlantic trade. The sum and substance of the argument is this, that if the Pacific Coast, centralised in the Pacific Northwest, is by position, internal resources, and the character of its people, fitted to become the industrial and commercial centre of this Empire, then an industrial development, an accumulation of wealth, a phase of culture, a breadth and intensity of all the activities of human life, which will be the final consummation of the great wave of migratory impulse which has peopled the North American continent, may be expected to be built up upon these shores.

There are certain peculiarities about the character of this tributary territory, however, which make the conditions of development entirely different from those which have contributed to the manufacturing supremacy of the Atlantic seaboard. The manufacturing communities of the east found themselves the masters of a vast inland empire, which was gradually filled up by people of their own race, or assimilated to it, speaking the same language or learning it shortly, inspired by the same ideals, and the victims of the same prejudices. The North American Indian was easily displaced, but the Mongol and the Spanish-American cannot be displaced. Commerce must therefore be developed along different lines. The countries commercially available to the Pacific Coast may be most readily divided into three classes:

1. Countries barren of population, but doubtless possessing extractable wealth. Such are Alaska, the northern portion of British

Columbia and of the Canadian Northwest Territories, and the northern portion of Siberia.

2. Countries which have belonged to the former class but are becoming civilised and populated under an impulse of development similar to that in North America—Australia and New Zealand.

3. Countries possessing considerable, in some cases ample, population, with customs, desires and idiosyncracies peculiarly their own. Of such are Mexico, Peru, Chile, Manchuria, China, Japan, the Philippines, the Dutch Indies, French China, Burmah, and British India, of which Burmah may now be considered part.

With all these countries important and profitable trade relations are being and may be established. But peculiar conditions are attached to every one of them, even apart from the general groups into which I have divided them.

Trade with countries largely barren of population, or, though populated, possessing resources of value to Europeans and Americans of which their people can neither appreciate nor extract the value, will await the same quickening impulse of energy and adventure which opened up and made profitable the middle and western States. This impulse may be strangled by the governments which control such countries. It is one thing to remove the Sioux or the Apache from the path of progress. It is entirely a different thing to uproot the prejudices of the Czar, or to bring a large part of his empire under a commercial dominion which he might view with suspicion and distrust..

As to the second class of country, trade must consist of an exchange of products which North America produces in larger quantities than required at home, for products which North America needs but cannot produce in sufficient quantities or with equal facility. This is trade upon an equal basis, and does not imply any dependence of the one country upon the other.

As regards the last class, trade depends first on the application of energy to make productive resources on which the people of such countries set no value, and second, upon the education of the people already productive, and therefore possessed of consuming power, to require American products as necessary to their comfort and well-being. Of the goods imported into such countries North America supplies a very small proportion. What it does supply is largely made up of the following and similar manufactures: Agricultural implements, cotton goods, electrical supplies and apparatus for scientific purposes, and manufactures of iron and steel, particularly in their

more intricate and complex forms. The trade is limited by some very simple but all-important considerations. One of these is the want of proper shipping facilities, another is the want of a commercial depot in the Orient, another the want of foreign banking facilities, and another the want of foreign commercial initiative on the part of manufacturers. Lines of shipping between Pacific-Coast ports and the Orient are the first essential to the control of Oriental trade. A commercial depot has already been provided in Manila. It must not be forgotten that quotations in American dollars, American methods of advertising, and American methods of collection, are completely incomprehensible to the Oriental mind. There must be some commercial interpreter. Great Britain has provided for that in Hong Kong. North America must do the same in Manila. Financial and banking methods are entirely different where they exist at all, and this must be provided for. The great Anglo-Oriental trading firms have always been bankers as well as traders. Foreign commercial initiative has not been characteristic of American manufacturers because they have had no need for it. Once the stimulus of a profitable export trade is felt, they may be relied on to develop it. American manufacturers have always had a large tributary territory to exploit, which economically speaking, is foreign territory, but in other respects is not. This territory has similar laws, language, religions, courts, and banks. But after all, what difference in nature exists between the trade of Massachusetts with Montana and that of Massachusetts with Manchuria? In the one case as much as the other, it is the commerce of a country producing raw materials with one exporting manufactured products.

A country may export raw materials and import manufactures; or it may export manufactures and import manufactures; or it may export manufactures and import raw materials, which it manufactures, partly for home consumption, and partly for re-export in exchange of different materials of other kinds which it is able to utilise. This is trade and commerce in their widest conception. It is the kind of trade which is realised in the commercial history of Great Britain, and it is towards this kind of trade that the redundant energy and resource of North America are reaching out. Now, the greatest part of the markets for export and import foreign trade which are open or valuable to North America must be reached through the ports on the Pacific. It is all very well to talk of the possibility of supplying steel and coal to Great Britain. But to take pride in supplying steel and coal and raw cotton to Great Britain, from which Great Britain forges

the machinery, generates the power, and produces the cotton goods which supply the markets of the Orient, seems one of two things—either a confession of inferiority, or a total misconception of the commercial situation as it confronts North America. Surely North America's trade opportunities lie where east and west are merged, where there is a market for manufactures, and whence may be drawn commodities differing in utility as one hemisphere differs from another.

In what way, however, does all this particularly affect the future of the Pacific Coast? In this way. The mere passage of commodities through a point does not of itself build up wealth or population at that point, but the fact of being on the line of commerce, and that closer to the market, is what gives a territory the opportunity to establish itself as a manufacturing and commercial country, provided it possesses the necessary resources and its people display the necessary energy. I have tried to show that the Pacific Coast possesses such resources in a pre-eminent degree, but that their development is yet postponed awhile by a number of present disabilities. These, however, are likely to be removed at least as rapidly as the foreign market is opened to its full capacity. The North American continent does not as yet fully recognise its destiny as arbiter of the future commercial life, to which the myriads of population, and countless agencies of production lying dormant in the Orient must awaken. But the day will come when the ports on the Pacific Coast are not only engaged in a great trade in the export of all classes of manufactures, but form a reservoir into which the untold wealth of Oriental nations is poured, there to be manufactured and transferred and adapted to the needs of a great and rich population extending from the Pacific to the Atlantic shore, to the refinement of whose mode of living the world is laid under tribute. Then, indeed, will great cities, "rich, crowded, laughing with the spoil of continents" be built up upon the North American shores of the Pacific Ocean, cities resounding to the hum of commerce, of manufactures, and of ship-building, and forming the ganglia of the commercial nerve-system of the world. Here, indeed, will the impulse of western civilisation be realised in its most glorious, perhaps its final, consummation. Here, in this Imperial situation, holding in one hand the keys of all Europe and America, and with the other embracing the commercial destinies of all Asia and Oceanica, western civilisation, in its peculiar industrial features, will attain a magnitude and a character of domination superior to every phase of it that has gone before, as each of these has been superior to precedent variations.

EQUIPMENT AND METHODS OF THE INDIAN DOCKYARDS.

By A. C. Bowden.

It has been said that one of the largest factors of Anglo-Saxon success in colonising is the racial gift of adaptiveness—the ability to produce effective results with a wide range of mechanical and human instruments. Mr. Bowden's paper has the particular interest of showing a striking instance of the display of this faculty.—THE EDITORS.



Entrance, Royal Indian Marine Dockyard.

MUCH has been made public concerning the ship-building yards of Europe and America, both government and mercantile, but little has been said of late of the expeditious output of work from the two dockyards of the Indian Government—so little that no doubt few of the readers of THE ENGINEERING MAGAZINE, except those who have visited the land of palms and plague, can imagine how advanced these government establishments are or how much of interest they display in their adaptation to peculiar conditions of labour and

environment. In this article I shall speak principally of Bombay, leaving Calcutta dockyard for future reference.

The Bombay dockyard, as well as that of Calcutta, is officered from the director of the Royal Indian Marine downward by home-trained admiralty officials, and here lies the root of success; for a record of the output of work clearly shews that officers of limited ability could not venture to cope with the calls made at these dockyards, Bombay in particular. Here may be seen at one time, and have been seen during the past year, equipments for hospital ships, transports for cavalry and infantry, and the usual routine of ship-building and engineering in course of construction. The P. & O. steamship Carthage left Bombay on August 9, 1900, a specimen of ability, and was



H. M. S. POMONA LEAVING THE WET BASIN.

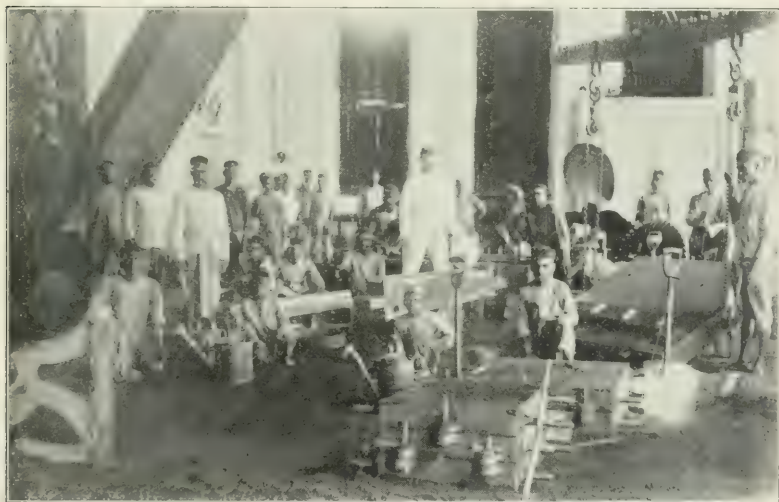
pronounced the finest floating hospital there has ever been. When I speak of the ship-building at this yard I do not mean of battle-ships, but of the lighter and more commercial line of construction—that of launches, tugs, and shallow-draught steamers for treacherous rivers. This present year will see the completion of one of the finest shallow-draught paddle-steamers built for India or elsewhere, for in this vessel the designing naval architect of this yard has embodied all the requirements asked for by the Public Works Department, which is saying a great deal, providing as it does accommodation for ten officers independent of the crew and servants. In this inspection steamer every up-to-date comfort is provided; the saloon is fitted as conveniently as possible, the cabins are furnished with spring chain sleeping berths, sofa seats, and folding lavatories; each cabin, closet, and galley is provided with electric light, and electric lanterns are fixed in the crew's quarters. The dimensions of this steamer are: Length over all, 234 feet 6 inches; breadth (moulded), 23 feet 6 inches; depth (moulded), 5 feet 6 inches; draught, 2 feet 6 inches. To accompany this inspection steamer when on river inspection an observation steam

launch 70 feet in length is provided, and this vessel also is fitted with equal care and comfort.

Bombay dockyard contains a boiler shop fitted with up-to-date hammers, rivetters, and furnaces, and from this shop some of the largest land and marine boilers have been turned out. The foundry, too, can compare favourably with any in India and is capable of castings up to 15 tons' weight. Steel castings can be made here, and in the near future great developments are expected in this direction. As will be seen from the photograph, all the workmen work barefooted.

The factory has done wonders in the building of factory engines, and engines for submarine launches and tugs up to 500 indicated horse power. The engines shewn on page 1005 were built entirely by native labour to the designs of the European engineer officials, the Europeans shewn in the view being engineer apprentices. A horizontal compound surface-condensing engine of 30 nominal horse power has been built during the past year and is now erected at Port Blair, the convict settlement of the Andaman Islands, and is working the factory there.

The electric shop at Bombay is ever modern, although in existence over ten years, the engine receiving steam from a large cylindrical boiler fired by liquid fuel. The whole of the dockyard is lighted by electric arc lamps, and the drilling and boring about the yard done by electrically driven motors. Some idea of the work done here can be gained by the estimates for work during the financial year 1899-1900 (April to March), exclusive of the great stress placed on the officials



NATIVE WORKMEN IN THE DOCKYARD FOUNDRY.

by the South African expedition, which commenced early in September, 1899. Through the energies of the officials of Bombay, eighteen transports with infantry and cavalry were despatched in eighteen days, and it is recorded went far to save the Empire. It is to be hoped,

when the honours are shared, these officers may be recognised. Since September, 1899, fifty-two vessels have been fitted up as transports at Bombay alone, independent of the six trips made by Indian Marine vessels. The estimates for the year amounted to Rs899,884 or, in English money, £60,000.

The mechanical organisation of the yard holds the secret of the successes obtained, and further proves the words of that American authority, Alleyne Ireland, who in his study of tropical colonisation, tells us that the Indian Government's system of organisation is most perfect, and the solution of British rule in India. At Bombay dock-

yard, the head of each trade (all under the guidance of a naval constructor), is a European officer, who gives his orders to his native chargeman (or "mistri" in Hindustani), and he in turn filters the work out to his less fortunate workmates; but in a country like India, with a populace full of caste prejudices, one is astonished to find men of all castes and creeds working amicably at the same trade side-by-side within the works, whilst outside they are as opposite in religion

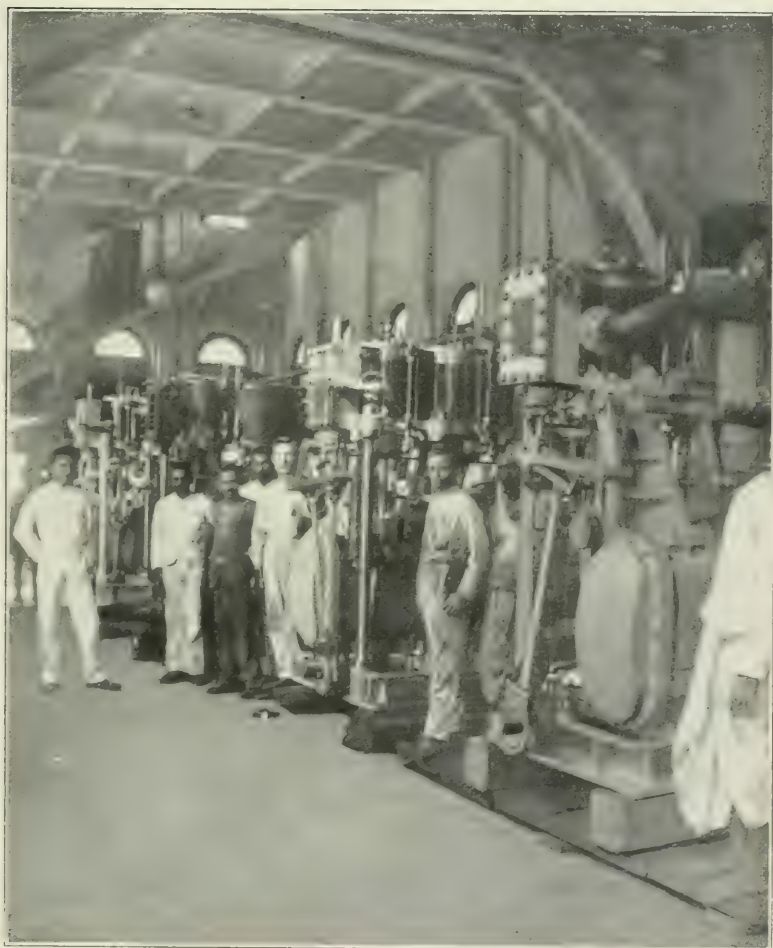


TORPEDO-BOAT WET BASIN.



THE HARBOUR, FROM BOMBAY DOCKYARD.

and ways as east and west and ready to riot one with the other at the least provocation. It certainly reflects great credit on the old school of the East India Company and Indian Navy, and the officers who followed at the abolition of these companies in 1803, when the Royal In-

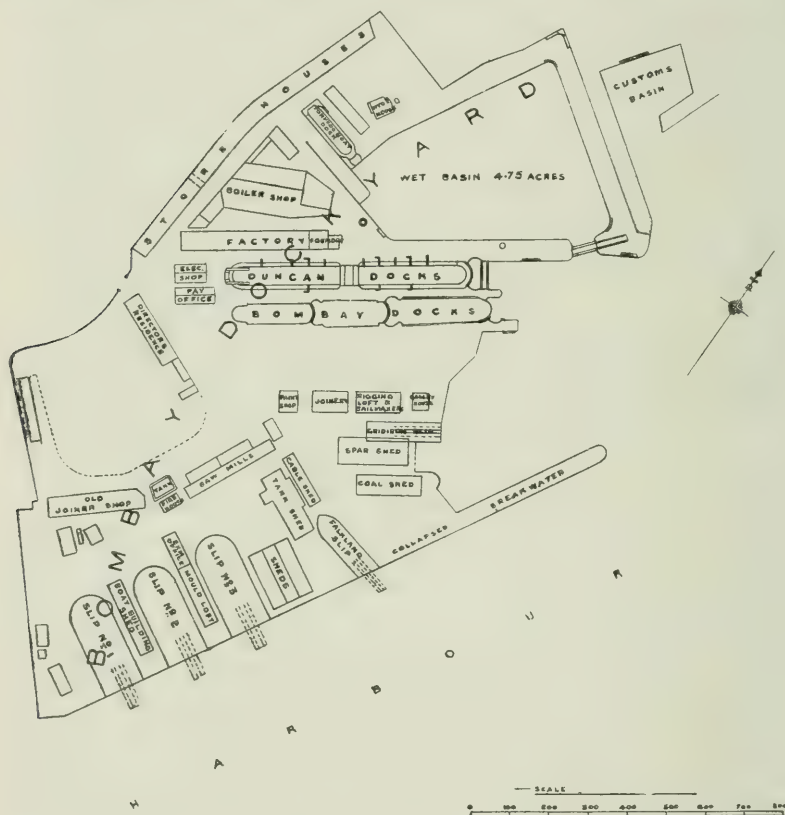


CORNER OF THE ERECTING SHOP, SHOWING GROUP OF LAUNCH ENGINES BUILT
BY NATIVE INDIAN LABOUR.

dian Marine was established; for they left a good sound foundation of organisation for the younger school to work upon.

The illustrations on pages 1007 and 1008, aided by the plan of the dockyard, shew clearly the docking accommodation available: in the foreground of No. 1 two out of three of the old Bombay docks can be

seen, also the open caisson door of the other, which is a covered dock, seen in No. 2. The lengths of the three docks in one line are: Lower, 256 feet; middle, 183 feet; and upper, 200 feet, with a breadth of 51 feet 9 inches. The next couple of docks are the Duncan docks, which have a combined length (with caisson removed), of 641 feet, the upper dock being 302 feet long and the lower 316 feet, with a breadth at the



GENERAL PLAN OF BOMBAY DOCKYARD.

entrance of 60 feet. The photograph produced is a fortunate one, as on the day it was taken the whole of the docks were empty for one tide only, the first time this has happened since June, 1897. Beyond these docks is the wet basin with several Royal Navy vessels under slight repair, the vessel in the foreground being H. M. S. Sphinx, employed generally on special service in the Persian Gulf.

The wet basin has an acreage of four and three quarter acres, out of which a small torpedo-boat dry-dock is led, and also a covered

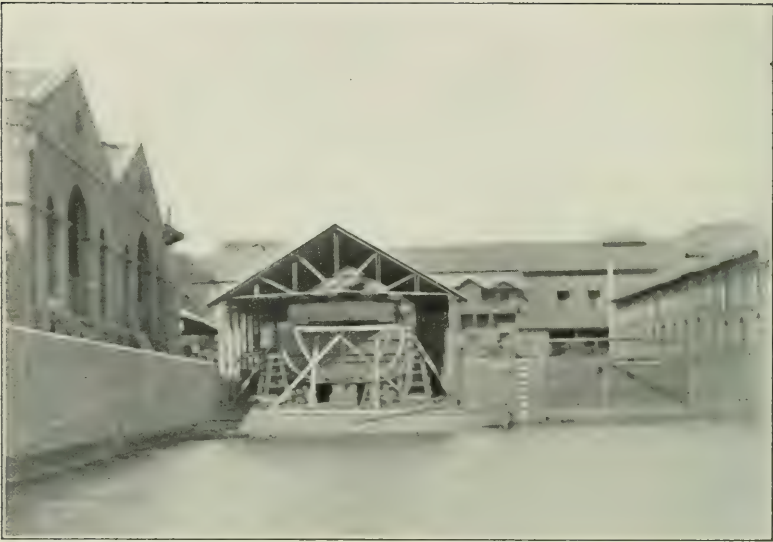


No. 1. Two of the three old Bombay docks—256 and 183 by 51 feet.

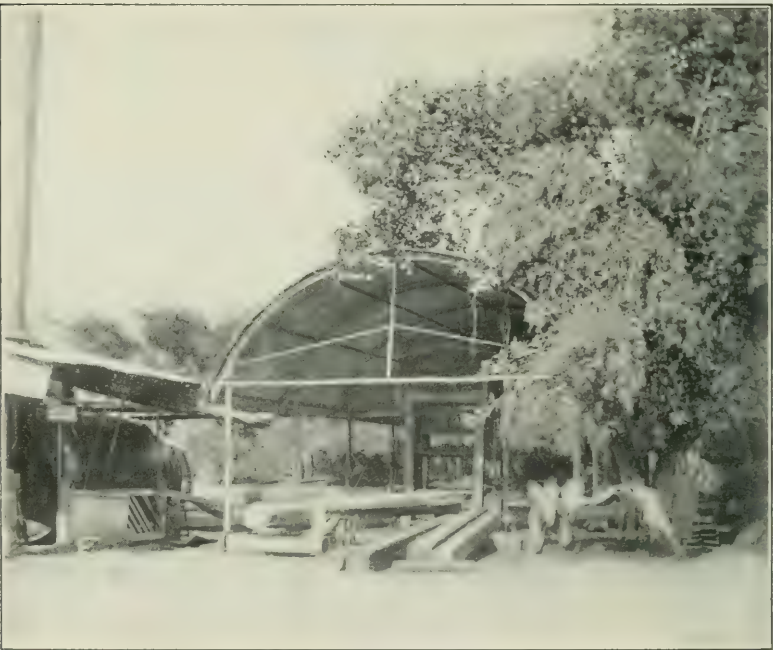


No. 2. Covered dock the uppermost of the three referred to above.

DOCKING ACCOMMODATIONS AT THE BOMBAY YARDS



BUILDING SLIP AND ENTRANCE TO TORPEDO-BOAT DRY-DOCK.



THE SAW-MILL.

building slip; the engraving on page 1008 shews a steel barge in course of construction on this slip, and the caisson gate at the entrance of the torpedo dry-dock, the buildings in the background and side being storehouses for Indian Marine and Royal Naval stores.

The photograph on this page shews No. 2 building slip with two



NO. 2 BUILDING SLIP.

submarine mining launches almost completed; from this slip and from No. 1 several vessels of large dimensions have been built and launched.

The yard possesses altogether six dry-docks and a wet basin, one dry-dock with its caisson removed being 640 feet long by 60 feet wide. The dock gates, capstans, and cranes are worked by hydraulic power, and are the production of the noted firm of Sir W. Armstrong & Co., Newcastle-on-Tyne. There are also three covered-in building slips where vessels of large dimensions can be erected and launched.

The equipment of the yard both in machinery and appliances is far more up-to-date than a stranger would imagine, for in the new join-



LOADING HORSES ON A TRANSPORT AT BOMBAY DOCKYARD.

ers' shop can be seen general joiners, boring machines, planers, etc., and when completed this branch will be a credit to this side of India. The saw mill is far too small for the calls made upon it at times, but the old vertical saw with its ten blades has been on the move almost continually for the last fourteen months and proved itself worthy of existence.

The cranes about the yard are many and varied, the heaviest being a tripod sheer capable of lifting 35 tons; this towers over the middle of the upper Duncan dock. There are two 25-ton cranes near the wet basin, around which several light whip cranes run on rails for lighter weights; the No. 2 view of the docks on page 1007 shews clearly the sheer legs, the building in the background being the factory and foundry, under one roof.

Bombay, with its yacht club, make a special demand on the dockyard, for a class of racing yacht—"Tomtit class"—was designed and built at this yard; so that vessels of every order, from the flagship of



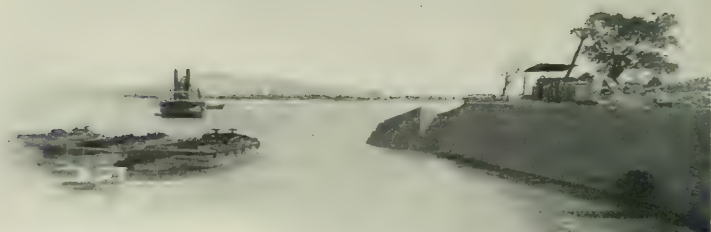
ELEPHANT STACKING GOVERNMENT TIMBER.

the East India station to the racing yacht, look to Bombay for outfit and refit. The storehouses here are many and varied, being divided into sections arranged for the reception and proper care of Admiralty and Indian Marine stores.

The troop-ships of the Indian Marine have proved a valuable adjunct to the Royal Navy, and it is to be hoped that the new transport



THE ROYAL BOMBAY YACHT CLUB.



Collapsed Breakwater.

"Hardinge," building at Fairfield Ship-building and Engineering Co., Glasgow, and due to be handed over to the officials at Bombay in the early part of 1901, may be but one, and a precedent of an Indian trooping service, which would prove itself an efficient and valuable branch of the Admiralty, as it has, in a small way, during the present year.

It may be said in conclusion, that although much has been written in this article of the up-to-date state of Bombay dockyard, yet in the near future an idea will be carried into effect that will make Bombay one of the finest embarking stations in the world; for by the reconstruction of the collapsed breakwater, the construction of another, and the reclamation of some foreshore, Bombay will be enabled to transport regiments of cavalry or infantry at any tide, the railway running down the new breakwater from a branch of the Great Indian Peninsular Railway, so that the troops will be landed from up-country close to the transports ready for departure.



ECONOMY IN FUEL COMBUSTION AND STEAM GENERATION.

By William Wallace Christie.

Progress in steam engineering in the future must be, as it has been in the past, in the line of bettered economy in power generation. The twentieth century may reveal some new and vastly more efficient cycle of transformations than we now know; but for a long time the furnace, the boiler, and the engine will be the three tools on which study must be centered. Mr. Christie deals lucidly with the first of these.—THE EDITORS.



HIS twentieth century, upon which we have just entered, will be noted, perhaps before other things, for the great economies which will be suggested, acted upon, and pushed to their maximum in connection with all of the many trades, processes, mechanical operations, shop management, and power generation and transmission. Heretofore, for example, coal has been furnished to the consumer by the ton, thrown into the furnace, and, as a friend expressed it, "all we know is that the steam is made and the work is done." The world is beginning to realize that there are (as there always have been) about 14,000 British Thermal Units in one pound of good coal; therefore, since coal is bought for the heat it gives in return, they look for results.

If a steam engine develops an indicated horse power on 100 pounds of water, there are but few who do not recognize in that figure a great waste. How many steam users, seeing a boiler horse power developed with 7 pounds of coal per hour, know that $3\frac{1}{2}$ to 4 pounds would be nearer the economy attainable if we used efficient means for getting all of the heat possible from the coal to the water in the boiler? The boiler which gives the greatest economy, and consequently the highest efficiency, is the one whose furnace proportions, construction, setting, and care are all given the most thorough study. Many steam plants in operation, for lack of this forethought, are miserable failures as economical steam producers. Each of the items requires the fullest consideration. This article will be devoted to the setting proper.

Ashes, which accumulate under every boiler, need but little room; space sufficient for the ordinary accumulation of refuse should, however, be left, so that the draft will not be interfered with nor the grate

suffer injury. The distance from boiler-room floor level to the top of the grate bars varies in different types of settings: from 24 to 30 inches is current practice in stationary boilers. In large plants, however, where the boilers are worked hard and continuously night and day, the ash pits are provided with hopper-shaped bottoms or floors, terminating in tubes having closed ends, so that the ashes may be more easily removed by conveyors or by cars running underneath the tubes; in plants of lesser magnitude the wheelbarrow and the man behind it are employed.

Directly over the ash pit is placed the grate, which has an important part to perform in distributing the air through the fire, as well as in supporting the fuel during the process of combustion: 12 pounds of air are needed for the complete combustion of one pound of coal, theoretically; with ordinary natural draft, if poor, 100 per cent. additional air must be supplied, or 24 pounds of air per pound of coal; with mechanical draft and closed ash pits, only 50 per cent. additional air is required to give good results—18 pounds of air per pound of coal.

The sizes of coal commonly burned in the United States are classified thus:

-sizing tests—round holes and punched plates.

Chestnut	through 1 1/2 inches, over 7/8 inch.
Pea	" 7/8 " " 9/16 "
Buckwheat	" 9/16 " " 3/8 "
Rice	" 3/8 " " 3/16 "
Barley	" 3/16 " " 3/32 "
Culm	" 3/32 " " "

The size of the coal determines the air space which it will be desirable to have in the bars, which has been standardized in this way: *

1/4 inch opening, 3/8 inch bar for screenings.
3/8 " " " 3/8 " " " buckwheat coal.
1/2 " " " 1/2 " " " nut or pea " "
5/8 " " " 1/2 " " " stove " "
3/4 " " " 1/2 " " " egg " "
7/8 " " " 1/2 " " " broken " "
1 " " " 1/2 " " " lump " "
5/8 to 3/4 " " " 1/2 " " " bituminous " "

The particular style or pattern of bar used may be selected according to one's liking. Some engineers have a preference for the rocking over the stationary grate bars, others for the herring-bone tupper bar over the common single or double slab bar. Shaking and dumping grates, if operated in two or more sections, allow the fire to be cleaned without requiring the fire doors to be opened as great a

* For more complete table see Chimney Design and Theory, by W. W. Christie.

length of time as is imperatively necessary in hand cleaning. I have found a saving of about 3 per cent. in dumping grates over stationary tupper bars, used under the same horizontal return-tubular boiler; the economy was due principally to the saving in time required for cleaning the fire and consequent prevention of the inrush of a large volume of cold air. Grate bars set at a slight inclination toward the back of the furnace give better results than those which are perfectly level; a drop of 3 inches is recommended by the Hartford Steam-Boiler Insurance and Inspection Company. This company also advise a cement-concrete ash pit 6 inches deep, with sloping sides below boiler-room floor level, allowing the ashes to be quenched with water and to be easily drawn out on the floor.

Mr. G. H. Barrus, reporting on tests of a boiler under which the fuel was fired in various ways, records that with uneven fires an equivalent evaporation of 9.149 pounds of water from and at 212° F. per pound of combustible was obtained, as against 9.55 pounds of water with even firing—showing a substantial benefit or gain due to careful firing, and incidentally the value of “brains” in the boiler room. The various stoker methods of automatic fuel-feeding or firing and their special grates will not be discussed at the present time.

Open fire, ash-pit, and boiler doors result in a positive injury to any and all boiler settings, and prevent at the same time the attainment of the greatest efficiency. The opening of a door over the fire for a moment reduces the temperature of the escaping gases very considerably, a drop of 100° F. having been observed by me.

The distance between the grate bars and the metal which composes the boiler shell containing the water to be evaporated is a most important dimension, meriting a separate consideration for each boiler setting. It depends not only on the kind of coal to be burned, but likewise on the rate and intensity of the combustion. Many engineers use 30 inches as the proper dimension for a 100-horse-power boiler, though as great a distance as $4\frac{1}{2}$ feet has been used. In the Manning type of boiler the height of the crown above the top of grate is about 3 feet for a 100-horse-power boiler; within the last three years some special boilers of this general type have been built having the fire box about twice as deep; the results under test have not been made public.

The rate of combustion also plays a most important part in the efficiency of a boiler. It may be low on a large grate area, high on a small grate area, or medium on areas intermediate between these extremes. Prof. Goss has experimented with a practically uniform quantity of coal burned in a given time, in a locomotive boiler, and

by varying the grate area he secured rates of combustion widely different, obtaining these results in evaporative efficiency:

	1	2	3	4
Coal per sq. foot of grate per hour, lb....	61.40	83.50	124.20	240.80
Equivalent evaporation from and at 212°, lb.....	8.26	7.87	7.52	6.67
Equivalent evaporation per square foot of grate, lb.....	15.00	19.00	26.00	47.00
Smoke box temperature.....	647°F.	629	610	500

These figures show that even with forced draft, beyond a certain rate of combustion, the temperature of the escaping gases decreases, and the highest efficiency is obtained with the highest temperature in the flue. Anthracite coal requires a larger grate area and air space in the bars than bituminous coal, so that the amount of coal burned in an hour, and its character, become of secondary consideration only to the area and disposition of the heating surface. Many boilers are failures as economical steam generators because of the lack of consideration given one or more of these details.

As the fuel gets poorer in quality and comes to the boiler room in smaller particles, the draft necessary to burn it is greater; consequently to avoid the expense and outlay of money for chimneys tall enough to burn slack, culm, or other inferior grades of fuel, mechanical methods are often employed to produce the desired draft.

We now come to the heating surface, whose function is to afford the least resistance to the passage of the heat from the gases to the water, and at the same time to contain and hold that water in the hottest parts of the fire. The ratio of heating to grate surface in stationary boilers is about 35 to 40, but in my opinion the heating surface should always be proportioned with regard to the pounds of coal to be burned per hour on the grate, and consequently with regard to the boiler horse power to be developed. A fair average of American practice in stationary boilers is one square foot of heating surface* for each 0.3 pounds of coal burned per hour per square foot of grate. With one of the types of vertical boilers tested under varying rates of combustion, the highest economy was secured when the area of the heating surface divided by the area of grate surface was 34.2 and when 0.28 pounds of coal per hour were burned on the grate for each square foot of heating surface.

C. Wye Williams says "a rapid combustion is more economic of time, and slow combustion of fuel," which statement, though made

* See table, p. 25—Chimney Design and Theory, by the author of this article

many years ago, is full of force to-day. The best rate of combustion for most economical evaporation of water, as far as fuel is concerned, is when about 13 pounds of anthracite coal are burned per square foot of grate per hour,* while for bituminous coal a slightly heavier fire is needed, and the above figure should also be greater.

For the relative economy of anthracite and bituminous coal under locomotive boilers we have these results from two prominent railroads:

	1.	2.
Bituminous coal.....	68.3	54
Anthracite ".....	65.3	50
Anthracite waste.....	69.4	—
Bituminous ".....	64.3	—

Tests made by me upon two Manning vertical boilers, with two coals, under the same conditions, gave these results:

	Buckwheat coal test.	Bituminous coal test.
Temperature of escaping gases.....	372° F.	427.16° F.
Rate of combustion.....	18.15	17.80
Nominal rating, horse-power.....	500	500
Boiler horse-power developed.....	431.65	493.86
Water evaporation per square foot of heating surface per hour.....	0.198	0.227
Equivalent water evaporation from and at 212° per lb. of combustible.....	9.80	9.81

Here, too, we have greater efficiency, with increased flue temperature. Other tests, with different boiler settings, could probably be suggested to show the superiority of anthracite coal.

The area or cross-section between the top of the bridge wall and the boiler shell, in the type of steam generator which has a bridge wall, is given by one authority as $1\frac{3}{4}$ square inches per pound of coal burned per hour on the grate. When tabulating the contents of the combustion chamber of horizontal return-tubular and Manning types of boilers, I found that, with one Manning boiler tested at five rates of combustion, the greatest efficiency was reached when one boiler horse power was developed with 0.89 of a cubic foot of air space in the combustion chamber. For the horizontal return-tubular boiler, one boiler horse power was developed very efficiently with 1.03† to 2.08 cubic feet of air space in the combustion chamber.

A horizontal return-tubular boiler 68 inches in diameter by 18 feet long, having 87 3-inch tubes, burning anthracite coal on a grate area of 34.5 square feet, developed one boiler horse power with 1.03† cubic feet of air-space in the combustion chamber and did so efficiently;

* Paper DCCXVII.—Trans. A. S. M. E., Vol. XVIII.

Paper DCCLXV.—Trans. A. S. M. E., Vol. XIX.

† These tests were made at different times—not by the same person.

when the same boiler had its draught forced 60 per cent. it showed a decided loss in evaporative economy.

Mr. John Bourne* gave the relations of the parts of a boiler as follows in parts per boiler horse power :

	Cubic feet between.	Cubic feet, average.
Capacity of furnace chamber above grate bar.....	0.78 and 1.7	1.17
Water space in the boiler.....	3.74 " 7.3	5.
Steam " " "	1.4 " 5.7	3.2

Thus far we have had in mind only the ordinary self-contained furnace, underneath the boiler, in which all the radiant heat is immediately about the shell ; a type of furnace is, however, being brought prominently into notice now which is separate from, and is placed in front of, the boiler setting proper ; it has an arched top, lined inside with fire-brick, so that the fire produces in it almost a white heat, and the gases, which are partly consumed in the furnace, pass out very hot about the boiler, where the combustion is completed, the air being mixed with the gases before they are cooled down, as in ordinary furnaces. By the use of two or more fire doors and alternate firing quite a uniform heat can be maintained. The combustion chambers virtually become gas producers ; this type of furnace is one especially adapted for the burning of bituminous and semi-bituminous coals, and gives a very high evaporative efficiency. In addition to these we have the down-draft and other patent furnaces and also mechanical stokers.

The marine boiler is frequently used on land, and when set up out of doors, with no covering or lagging, not even a shed for its protection, becomes more of a condenser than boiler in rainy weather ; but with a good setting and the proper insulation of its exposed outer shell, high evaporative results may be obtained. A gun-boat type of boiler with a corrugated-steel fire box tested by Dean and Main with varying rates of combustion gave for temperature of escaping gases the following results :

Rate of combustion, lb., per sq. ft. of grate per hour.	Temp. escaping gases, degrees F.
20.9.....	482
21.3.....	472
28.1.....	516†
28.5.....	496
29.3.....	511
31.6.....	526

The above is an example of a good installation of the marine type of boiler.

* "Artisan Club" Treatise on the Steam Engine.

† This test gave the highest evaporative efficiency.

The locomotive boiler is another favorite for land use in certain parts of the United States. Some years ago the Calumet and Hecla Mining Company had a large number of locomotive boilers built for stationary use, from special designs, which are said to have given good results. The tubes in this type, as used "on the road," are, however, of small diameter; they quickly become clogged with ashes and soot unless a very strong draft is furnished when the boiler is used for stationary work.

From exhaustive tests it has been proven that the resistance to the passage of heat from gases to water is usually 300 times as great as the resistance of a copper plate $\frac{3}{8}$ of an inch thick. The efficiency of the boiler therefore does not depend upon the thickness of the metal in the shell, but rather upon good circulation—upon carrying steam away from the hottest parts of the shell and allowing water to take its place. Extra length of boiler tubes in locomotives is of no practical value so far as concerns increase of steam-generating or heating surface, as we see from some French experiments conducted with boilers having tubes of varying length. The gases, as they passed through, suffered very little diminution of temperature or loss of heat at the far end after a certain length of tube had been exceeded.

The maximum length of locomotive-boiler tubes in the United States is 16 feet to 16 feet $7\frac{3}{4}$ inches for a tube 2 inches in diameter; elsewhere lengths of 17 feet 5 inches to 18 feet 1 inch are used with success, and even tubes having a length of 20 feet are considered practicable. The effect of a greater or less number of tubes in a boiler is shown by tests made with a Wigan boiler; the tubes all being open, a rate of combustion of 25 pounds of coal per square foot of grate per hour gave 12.4 pounds of water evaporated from and at 212° F. per pound of coal. Plugging alternate diagonal rows of tubes, thus reducing the heating surface by 206 square feet, resulted in an equivalent evaporation of 12.2 pounds at a rate of combustion of 24 pounds of coal per square foot of grate. In the first case light smoke lasted 2.8 minutes; in the second, 8 minutes. From these tests, as well as from others, it may be seen that with twice the velocity of the gases in the tubes we have twice the evaporation from each tube, without any material loss in the efficiency of the boiler. Does it make a great difference then, as some would have us believe, whether we have seventy 4-inch or forty-five 5-inch tubes in a 72-inch diameter horizontal-tubular boiler shell, or even a less number of either, provided we supply the proper draft?

There are still many men, who, when setting a horizontal return-

tubular, build a tight brick arch over the top of the setting, thus passing the gases over the top of the boiler entering the chimney flue from the rear. This manner of construction cannot be too strongly condemned, for it not only prevents ready inspection of the boiler, but also is not productive of any greater evaporative efficiency; in certain cases it may prove a positive detriment, for if the gases become too cool to give up any more heat to the boiler they will abstract heat from the steam already made.

The side walls of boiler settings are often built as one solid wall, but if they are built with a 2-inch air-space (front wall excepted) the walls are more substantial than when solid; more masonry is required than for a single wall.

Particular attention should be paid to the laying up of double walls so that they are not tied together in the masonry, as the fire side of the wall expands considerably more than the outer portion and rigid interlocked connections cause cracks. The excess of expansion of brick over iron in boiler settings is about $2\frac{1}{2}$ inches for the fire side and 1 inch for the cool side, in 15 feet, and cannot be ignored by designers. Not allowing for this difference in expansion is the cause of a great many cracks in boiler-setting masonry.

After the gases leave the boiler—in which they should circulate about the heating surface in such a manner as to give up all but so small a margin of their heat as will still leave them at a temperature exceeding that of the steam—they pass through the gas flue to the chimney or blower. The path of the escaping gases to the chimney should be as direct as it is possible to make it. An angular bend of ninety degrees offers twice as much resistance to flow as a curved bend of ninety degrees having a radius of say four times its diameter, if round, or four times its width if rectangular.

Gases in passing from a boiler through a 27-inch diameter flue having a curved bend with a center line of 48-inch radius suffered a loss of 10 per cent. of the draft they had before reaching the bend.

In designing ninety-degree or other angle bends, if we should enlarge the cross-section through the bend 25 per cent. for ninety degrees, and proportionately for other angles, the friction loss would be reduced to a minimum. Gas flues should be protected by some sort of an insulating covering throughout their entire length, for the economy of the boiler will be materially assisted by maintaining the temperature of the escaping gases without a drop, from the time they leave the boiler breeching until they reach the chimney; for the in-

tensity of the draft is a direct function of the absolute temperature of the escaping gases.

The equivalent evaporation of 12 pounds of water per pound of combustible may be taken as a standard of evaporation; with a good grade of coal this should be possible in a good setting with a temperature of the escaping gases of 500° F., or slightly less; if a higher temperature exists, we would, for the ordinary rates of combustion, have a decrease in economy to the extent of about 5 per cent. for each 100° F. elevation of temperature of the escaping gases.

The influence of a particular type of setting upon the efficient working of its boilers is shown by the following tables:

BOILER A.

Rate of combustion, lb...	10.66	11.69	13.32	14.84	17.2	17.63	21.74	28.28
Temperature of escaping gases, F.....	462	478	480	485	421	543	503.8	654

BOILER B.

Rate of combustion, lb.....	10.9	10.9	13.16	13.6	14.7	15.3	23
Temperature of escaping gases, F...	420.5	477	500*	522	495.9	554	531.4

BOILER C.

Rate of combustion, lb...	10.88	13.1	13.87	15.3	17	17.2	18.7	19.7	20	20.8
Temperature of escaping gases, F	608	652	700	716.5	602.8	463.7	697	588	622.8	611.8

With a uniform range of rates of combustion,

Boiler B gives off its gases to the chimney at 420°—531° F.

Boiler A gives off its gases to the chimney at 462°—654° F.

Boiler C gives off its gases to the chimney at 463°—697° F.

which gives a fair idea of the relative value of the settings.

The length of the gas flue, when about 800 feet, without a bend, decreases the draft one-half.

The draft at various parts of a setting, as actually measured in a certain boiler, gave:

At the chimney base, 0.514 inches of water;

At the second pass, 0.445 inches of water;

At the top of first pass, 0.394 inches of water;

At the furnace, 0.242 inches of water;

Showing a well-protected gas flue.

Oval or round gas flues, like round chimney flues, offer much less resistance than do square flues, and the gases when passing from them up the chimney should have a curved path, not an angle, as in the usual method of construction.

We often find that the area of gas flues and their entrance ar-

* Most efficient.

rangement into the chimney are adapted only to present requirements; for example, in a brick chimney designed for four boilers, the flue entrance to the chimney had the proper area for two boilers, while the gas flue area was inadequate for two boilers. With these conditions existing, a second boiler, with its smoke flue, had been added to the original boiler setting, a third added to the second—in each case extending the original flue area.

On the continent it is customary to use brick chimneys having the gas flue built of masonry laid and entering the chimney below the ground level. In the United States the contrary obtains, gas flues of steel being used in the majority of power plants, entering the chimney above the ground level, thus reaching the chimney at a place of greater weakness than when entering below the ground level; frequently two gas flues enter the chimney from opposite sides, which is very undesirable.

The area of the chimney flue should be proportioned in accordance with the capacity desired in it; the height should be sufficient to provide, with a given flue temperature, the necessary intensity of draft to burn a definite amount of coal, though a chimney much too large for present needs, with no immediate prospect of increased boiler plant, is not desirable. It would be better to erect another when the greater need comes, so connecting the flues leading to them that either or both may be employed in emergencies.

In an exceedingly large plant it is not wise to place all of your confidence in one chimney; chimneys in multiple are better.*

After having introduced to the reader some general rules of practice, which, if followed, will result in a commercially perfect boiler setting, the essentials may be summarized as follows:

1. Proportion all of the parts for the work to be done.
2. Use only the best materials and workmanship in construction and setting.
3. Keep the boiler clean, inside and out.
4. Watch the temperature of the escaping gases; do not allow it to rise above an economical point.

Authorities differ on this point, for 273° F. + outdoor temperature, or about 340° F., is given by one authority, 584° F. by another, and 600° F. by still another authority, as that temperature of the gases in the chimney which will produce maximum draft and delivery of gases. The tests quoted in this article show 500° F. or less to be an economical point, so far as the evaporative efficiency of the boiler is concerned.

* Railroad Gazette, Oct. 19, 1900.

GOLD MINING AND MILLING IN WESTERN AUSTRALIA.

By A. G. Charleton.

II. GENERAL GEOLOGY OF THE GOLD-FIELDS, AND THE PROCESS OF DRY BLOWING.



HAVING dealt with the history, position, and general features of the Coolgardie and Kalgoorlie gold-fields, with special reference to their topography and to the various agencies that have contributed to produce the results which are to-day visible *on the surface*, I will now pass on to the *internal geological structure* of the central plateau of Western Australia, in order to arrive at some idea of the conditions under which its gold deposits have been formed, and the local peculiarities which characterise and distinguish them from ordinary auriferous lodes and alluvials in other districts.

Treating the subject from the broadest possible point of view, the greater portion of Western Australia seems to consist of crystalline rocks of Archaean age, composed of granites, gneisses, and schists, which cover large areas distinct from one another, running in parallel belts approximately north and south with a slight northwesterly trend. Notwithstanding, however, an outward appearance of similarity, as will be seen later on, when studied in detail the same belt may present locally considerable diversity in geological structure; this no doubt explains the existence of enormously rich gold deposits in certain areas and their poverty or absence in others, although to the superficial observer the surrounding conditions seem much the same.

Mr. H. P. Woodward, F. G. S., F. R. G. S. (late government geologist), considers that there are six of these belts, each possessing distinctive features of its own.*

I. The most westerly belt, which extends along the shores of Western Australia, from the south coast to the Murchison River, which is seen exposed at Northampton, the Irwin River, and between Capes Naturaliste and Leeuwin, consists of clay slates, quartzites, and schists, which are characterised by the frequent occurrence of copper, lead, zinc, iron pyrites, and ferruginous graphite.

*Mining Handbook to the Colony of Western Australia. Perth. By authority.

Mr. Charleton's preceding article appeared in THE ENGINEERING MAGAZINE for February, 1901.

2. The second belt, which lies parallel with the first, forms the bold escarpments of the Darling Range, turning northeast beyond the Murchison River, and 200 miles further north disappears beneath a magnesian-limestone formation. In this belt the rocks are composed of hard crystalline gneiss and schist, penetrated by dykes of diorite, granite, and felstone, and veins of quartz, in which several minerals of commercial importance are found, viz., tin (at Greenbushes), iron, manganese, mica, asbestos, and graphite, of which a deposit was discovered near Bridgetown, in 1896.

3. The third series lies 100 miles east of the west coast, forming what Mr. Woodward calls "the great granite belt," which, so far as is yet known, seems devoid of workable deposits of mineral.

4. The first auriferous belt possesses a width of some 20 miles, and lies east of "the great granite belt," with which it runs parallel, starting at the Phillips River in the south of the colony, and passing through Southern Cross, Mt. Magnet, and Cue; then turning north-east at Nannine, it finally disappears beneath the Palæozoic rocks, where the Henry River joins the Ashburton.

The rocks of this belt are mostly hornblendic, micaceous, and talcose schists.

5. The next belt is nearly the same width as the last, and is very similar to it in character, except for the absence of payable gold.

6. The second auriferous belt, of which the width is yet unknown, extends from the Dundas hills, through Coolgardie, Ullaring, and Lake Carey, following a parallel line with the others, and turning, like them, to the northwest through Nullagine, Pilbarra, and Mallina.

The rocks in this area are very similar in general character to those of the first gold belt, viz., hornblende, mica, and talc schists.

Baron Sloet van Oldruitenborgh* believes that the table-land just described, of which the greater part of Western Australia consists, was elevated in Pre-Cambrian times, and was pierced by numerous overflows of diorite, diabase, etc. (probably of submarine origin), which were the precursors of the uplift to which the Australian continent owes its existence.

He observes further, that "very likely towards the end of the Permo-Carboniferous period, the probable sinking of the continent resulted in an intense compression in an eastward direction of the whole of this mass of rocks, generating an east-northeasterly thrust. extending along the coast of Western Australia for a length of about

* Technical Observations on the Coolgardie Gold Field by Baron van Oldruitenborgh, translated from the French for the *London Mining Journal*.

800 miles, which upheaved a doubly folded chain, running north-northwest, perpendicular to the direction of orogenical pressure."

The roots of this chain, which has since been planed down, are in consequence now exposed at the surface, and consist of the parallel belts of granite and gneiss, etc., of which mention has been made.

Mr. C. S. Göczel,* on the other hand, considers that in Palæozoic times this portion of the continent formed part of a volcanic archipelago, around which the greater part of Western Australia was built, and in early Mesozoic times (when the gradual upheaval of the continent was completed), volcanic action apparently died out in this part of the globe, although it continued to manifest some seismic and hydrothermal activity; the agency to which he ascribes the formation of most of the primary gold deposits, during later Palæozoic times.

With the elevation of the country above the sea, and the cessation of volcanic activity, Mr. Göczel considers a new era commenced, during which great depressions occupied by inland lakes and estuaries were successively filled in with rock material derived from the adjacent highlands.

He remarks, later on, speaking of Coolgardie,† that "The main fissures extend for miles, and contain predominantly eruptive rock-material, whereas ferruginous quartz, with a higher or lower gold yield, is only of secondary occurrence within them." The dykes consist, he says, usually of diorites, diorite-porphyrites, and porphyrites.

Dr. Chas. Chewings, Ph. D., F. G. S.,‡ like Baron van Oldruitenborgh, expresses the view that the Coolgardie goldfield is the remnant of a large mountain chain, almost obliterated by denudation, which marks a line of weakness in the earth's crust, through which the materials forming the chain were poured, whilst vast quantities remained beneath and have been exposed at the present surface through the removal of the upper portions.

He considers the prevailing metamorphic rocks in this area consist of schists and slates, which chemically range from the most acid to the most basic—petrologically, from amphibole§ to quartz-schist—and that they are probably of Pre-Cambrian age.

The absence of fossil remains, superficial deposits covering the

*The Interior Gold Region of Western Australia, Appendix 4, ad interim Report Depart. of Mines for half year ending June 30, 1894.

†Report of the Depart. of Mines for the year 1895.

‡Geological Notes on the Coolgardie Gold Fields, a paper read before the Royal Colonial Inst., March 17, 1896.

§Hornblende

bed-rocks, the want of accurate geological information about many parts of the colony (much of which remains practically unexplored), and breaks in the continuity of the series, even when the position of certain "formations" can be determined accurately here and there, all tend to render it difficult to settle the relative ages of the rocks of Western Australia, and strew the path of the wary but untiring geologist with difficulties.

Recent Superficial Deposits.—A large portion of the Coolgardie field is covered by recent superficial deposits, which vary in depth from a few inches up to some hundreds of feet (as proved by a section at what is known as Rollo's bore-hole), the flats and slopes west of the township being buried underneath this blanket of alluvium. On the surface, it consists of loose sand and quartz fragments, resulting from the decomposition of the granite, "cement," and quartz reefs, mingled with ferruginous matter derived from the hornblendic rocks and iron-stone gravels referred to later on.

The quartz particles are usually of small but varying sizes, and are more or less rounded by the action of the wind; whilst at greater depth, where they lie on the eroded surface of the granite, they are larger and are usually sub-angular, having apparently been exposed to the action of water in what seem to have been ancient subterranean water-courses.

Quartz of this kind, it is said, rarely if ever shows any free gold. The impure oxide of iron, of which a large part of the alluvium consists, is in a fine state of division on the surface; but lower down large, loose, rounded pebbles of iron-stone are met with in patches, and in many cases show free gold both in the exterior and on freshly broken surfaces. On approaching the granite on which it rests this deposit often becomes so compact as to necessitate the use of explosives to break it, being cemented together by the iron which has been dissolved out and re-deposited. Under a lens the finer samples show the presence of garnets and zircons, occurring in broken and partially worn fragments, together with magnetic iron, commonly known as "black sand."

Iron-stone Gravel Deposits.—The remnants of these deposits are found widely scattered over various parts of Western Australia, overlying the granite, and occur exposed in semi-detached patches in the Coolgardie field, following a north-and-south line on the outskirts of the alluvials, to which they have doubtless contributed much of the iron which imparts to the latter their red colour. At Coolgardie and elsewhere, however, when exposed at surface, this deposit has

been largely removed by denudation except where it lies in hollows in the eroded surface of the bed-rock.

Mr. Blatchford is of opinion that these iron-stone gravels have been most likely derived originally from older beds of ferruginous clay, long since altered *in situ* through concretionary action into iron-stone nodules, that have been changed at surface into the hard iron-stone pebbles which are so frequently met with.

In places these pebbles become re-cemented together into the lumps of impure iron stone which are often found outcropping on high ground, and as judged by a sample analysed in the government laboratory the composition of this iron stone appears to be: Fe_2O_3 35.25 per cent., Fe O 00.51 per cent., equivalent to 25.07 per cent. of metallic iron; assays made of the "gravels" show from 3 to 8 penny-weights of gold per ton.

They lie at Coolgardie at a tolerably uniform level between 1,380 and 1,460 feet above the sea, and Mr. Blatchford thinks that the same may be said to be the case in other parts of the central table-land. Their nodular appearance seems to be due merely to surface weathering, and he regards them as ferruginous clay-stones, resulting either from the deposition of volcanic dust or a detrital deposit derived from more or less basic rock, in either case deposited in water.

Whilst minor deposits of a somewhat similar character are found at lower levels, as at Coates' siding in the southwest portion of the colony and elsewhere, which evidently originated from the surrounding rocks, Mr. Blatchford contends that, in view of their wide distribution and the facts that have been already stated, there seems much likelihood that these singular iron-stone gravels are of marine origin, and he places their age between Jurassic and Miocene or Pliocene—probably the latter, judging from their lithological character. Underneath the iron-stone gravel, between it and the granite, patches of so-called "cement" are sometimes found forming a sub-stratum which attains in places an average thickness of about 3 feet; and although what little of it has been found at Coolgardie itself has not thus far proved payable, very similar cement deposits discovered at the 25 mile and at other places in the surrounding districts have turned out extremely rich.

Just in the same way that California and Victoria owe their early prosperity and rapid industrial development to the discovery of alluvial gold, so Western Australia is indirectly indebted in a great measure for its present thriving condition to the alluvial diggers, who, acting as pioneers of the mining industry,

paved the way for the quartz-miner and capitalist, who invariably follow in their wake. As Mr. T. A. Rickard justly points out, however, the discovery of the rich telluride lodes at Hannan's, and the development of "this immense desert country, dotted over with the unhappy failures which were based on small pockets of 'specimen gold-quartz,' did not happen without a sad expenditure of money and human life."

The peculiar character of the gold "rushes," is, in fact, in no small degree traceable to the nature of the gold occurrence, "since gold is found lying on the very top of the ground, and the first surface mining yields extraordinary profits" to the individual discoverer. Hundreds of ounces have thus been picked up by the first-comers, "specking" for gold, as it is called; the sandy patches of alluvial where discoveries of this kind are generally made being afterwards turned over and treated by the "dry blowers," who have trenched and pitted the surface in all directions in the search for a rich location.

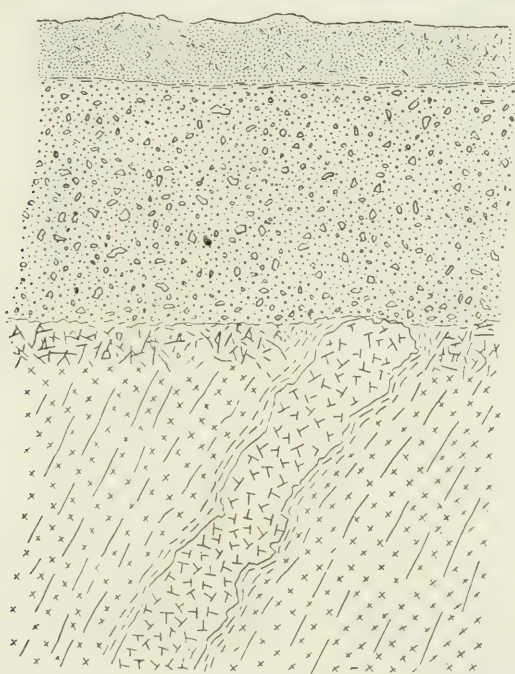
On Sundays and holidays, when regular employment is at a standstill, miners otherwise engaged during the week may be often seen out "specking," employing their leisure in quartering a likely spot, with their hands in their pockets and eyes bent on the ground, like men lost in deep thought; but it is devoted to one subject—the discovery of the lost trail of a nuggety bit of gold.

The fragmentary overburden of detritus of which these "superficial alluvials" consist (termed by the Australian miner "made ground," to distinguish it from the underlying bed rock on which it frequently rests), covers at times accumulations of consolidated auriferous material termed "cement," which, as Mr. Rickard observes,* "are more extensive, and quite apart from their greater economic value are also of superior interest, because of their better-defined geological features."

Alluvial Deposits.—The discovery of alluvial gold at Kalgoorlie was made on Saturday, June 17, 1893, by three prospectors—Patrick Hannan, Dan Shea, and Tom Flannagan—whilst travelling from Coolgardie to the Mt. Yule rush. The following Sunday hundreds of men were flocking to the scene of this find, on camels, bicycles, horses, and on foot, who little suspected the immense wealth that lay buried in the neighbourhood under the arid waste of reddish loam, gritty sand, and gravel containing iron-stone, travertine, and fragments of quartz, with which the surface of the country for miles around was covered.

* The Alluvial Deposits of Western Australia, by T. A. Rickard, A. R. S. M., State Geologist, Colorado. Trans. Am. Inst. of Mining Engrs., 1898.

The theatre of these early operations was below the hill which overlooks the township. Curiously enough, however, this discovery has not up to the present led to the discovery of any reefs of importance in the immediate neighbourhood, although the surrounding area, like many others, was given up to purposeless digging, which gave an impetus, as Mr. Rickard says, to a great deal of reckless company-promoting.



Quartz

Diorite

Cement

Loam

Broken

VEIN CAPPED BY ALLUVIUM.

Reproduced by courtesy of T. A. Rickard, Esq.

"However, just as in Colorado the Mt. Pisgah fiasco of 1884 preceded the real development, eight years later, of Cripple Creek, so the vagaries of irresponsible schemers led to the accidental opening up and the eventual recognition of the magnificent series of rich lodes that have now placed Kalgoorlie amongst the few great mining-camps of the globe," and towards the end of 1895 there were no less than 3,000 people congregated at Hannan's. Such veins as were found at the northern end of the field, however, were, as already said, so small, patchy, or poor, as to be practically valueless.



DRY BLOWERS AT WORK.

Reproduced by courtesy of T. A. Rickard, Esq.

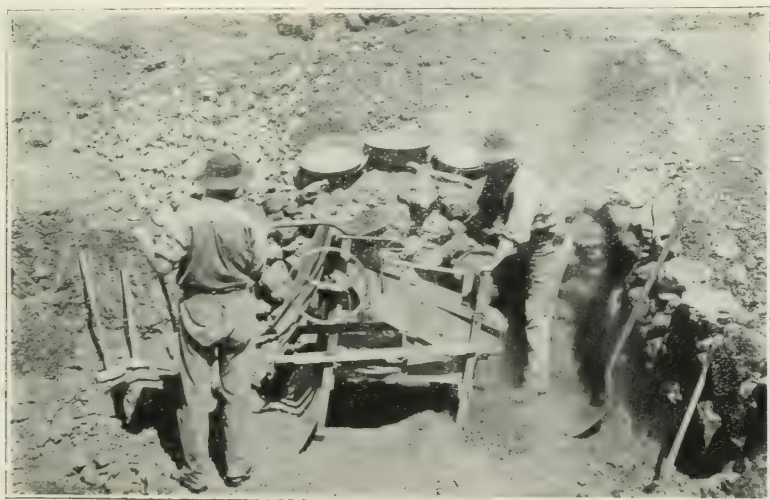
Alluvial Workings.—The gold obtained from this class of deposits has mostly been got from the loose dry surface-alluvials, by the method peculiar to Australia, known as “dry-blowing.” For its success, it requires most careful manipulation when the gold is finely divided; but in experienced hands it gives fairly good results. That a good deal of gold is lost, however, is proved by the refuse-heaps of the dry-blower, which average in many places 10 pennyweights to the ton by assay, left standing after the ground has been turned over.

In the absence of water, which prevents the employment of the cradle, tom, or sluice box, employed by the placer-miner in other countries, it is designed to utilise the agency of wind in place of water; and in the skilful hands of the “prospector,” this performs the function of sizing, classifying, and thereby concentrating the material a step further than nature has already done. The perfect dryness of the dirt, and the heat imparted to the iron-pan by a tropical sun, are factors which are indispensable for its success, imparting a mobility to the material which Mr. T. A. Rickard has aptly compared* to “the behaviour of a charge in the roasting-furnace, in which the hot air cushions each particle so as to give the mass an apparent fluidity.” He also points out in the paper referred to that much depends on the strength and uniformity of the wind. Fortunately for the dry-blower, there is generally a light breeze, except during sultry days in the

*The Alluvial Deposits of Western Australia. Trans. Am. Inst. of Mining Engrs., 1898.

height of summer and on the cloudy mornings in the wet season, both of which times of year are unfavourable for operations of the kind. The deposits worked in this manner are usually "patchy," and frequently lie at the head of shallow gullies, which start from ridges where a quartz vein outcrops, below which gold has been picked up on surface; and as Mr. Rickard remarks: "The distribution of gold in these deposits reminds one of its position on a vanning shovel. It may be traced up to the outcrop which yielded it, or it may be scattered in the sand for half a mile; but the rich and only workable part of the deposit will ordinarily be found at a distance of 30 or 40 feet from the reef." Doubtless, however, as previously explained (in last month's article), in certain instances the gold is derived from mere stringers and auriferous deposits other than quartz veins, and therefore the existence of rich alluvials does not always lead to the discovery of what can be strictly termed "a reef" in the immediate neighbourhood of deposits of the kind.

After the alluvial has been well shaken up, so as to bring to the surface the large lumps, which the "prospector" examines and skims off, dry-blowing, in its most primitive form, consists of dropping the "dirt" from a height, from one "dish" to another, the dust and finer particles being blown away in falling 4 or 5 feet through the air, whilst the gold and coarser gravel are caught in a second "pan" set on the ground at the miner's feet. He stands so as to face at right angles to the wind, placing the lower "pan" on a piece of coarse



DRY BLOWERS AT WORK.

Reproduced by courtesy of T. A. Rickard, Esq.

canvas, so as to catch any fine gold blown to one side over the edge of the "pan." This process is sometimes repeated several times, although once may suffice, shaking up the coarse lumps in the full pan on the ground so as to bring them to the surface again, picking them out, and pouring the residue back into the empty pan, as before.

The next stage is to toss the dirt up and down in the pan, holding the pan in a slanting position, away from the operator, and jerking it back, so as to throw the dirt from the front to the back of the dish, thus winnowing it still further. Then once more shaking the pan, with a vanning movement, he brings the lumps to the top and skims them off. When thus reduced to a small quantity of "fines," the auriferous residue is still further shaken down, like the contents of a dish, when panning it in water, and with the pan tilted forward, the miner raises it to his mouth and completes the process by blowing off the remaining light sand.

After this process of concentration is finished the gold is seen fringing the edge of the iron-sand; any nuggets or pieces coarse enough to "spec" are picked out, and the "fine gold" is either washed out with water in the usual way or collected with the moistened end of the miner's thumb.

The operations of the dry-blower, above described, are shown in the accompanying illustrations on pages 1030-1035, which are reproduced from the papers of Messrs. Rickard and Geo. J. Bancroft.*

This slow and laborious process is frequently superseded by a "machine" for sizing the material, operated on the same general principles, which, in its simplest form, is known as a "shaker," owing to the shaking motion imparted to it.

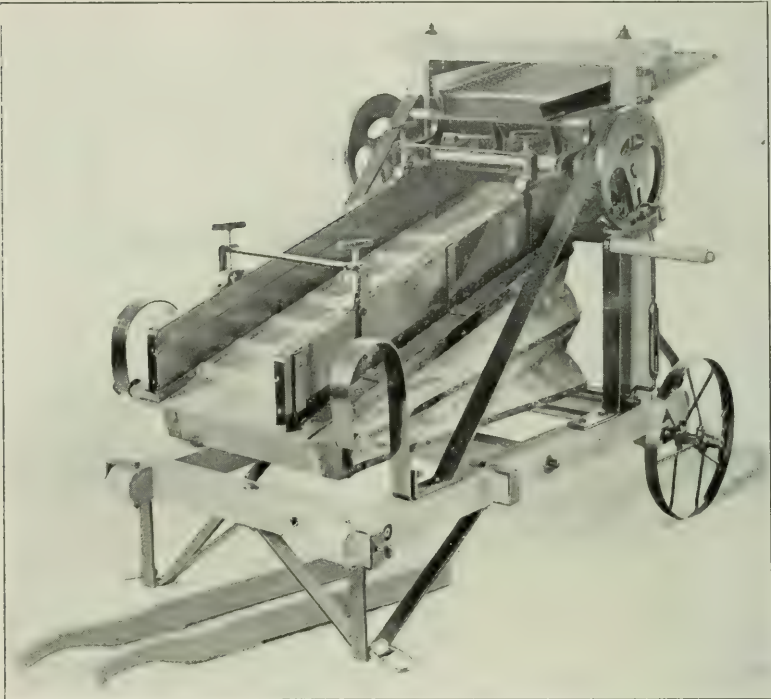
It consists of a couple of slanting frames (covered with screens of different sizes—generally 12 or 18 mesh—and provided with cross riffles), fixed on legs in such a way as to allow the miner to shake the material backwards and forwards. The dirt, which is fed on to the head of the frame through a hopper fitted with a sheet-iron bottom punched with 1-inch holes, passes down the inclined screens, the finer particles falling through, the coarser ones being discharged over the end, and the gold grains and nuggets accumulating behind the riffles. The "fines" collected underneath the frame are subsequently treated by hand, by the method first described. Such a machine measuring 4 feet by 2 feet will put through about 5 tons of loose dirt in 7 hours.

*Kalgoorlie, Western Australia, and Its Surroundings. Trans. Am. Inst. of Mining Engrs., 1898.



A DRY BLOWER AT WORK.
By courtesy of T. A. Rickard, L.S.

A more elaborate contrivance to fulfil the same object is illustrated in Mr. Rickard's paper and consists of a series of flat trays with sieve bottoms, hung on a tripod: several other machines of the same char-



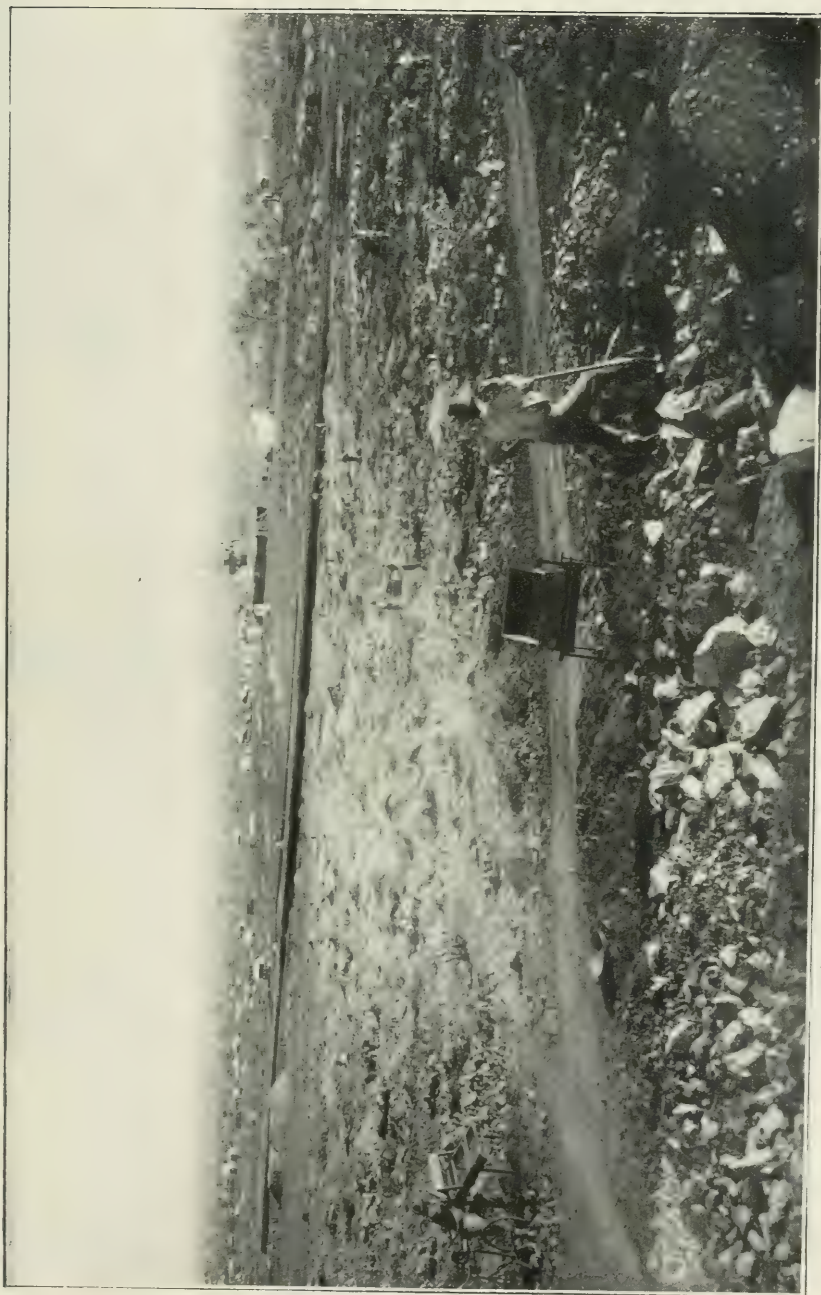
WOOD'S DRY BLOWER. PROSPECTING-MACHINE TYPE.

Fraser & Chalmers, Chicago, Ill., U. S. A.

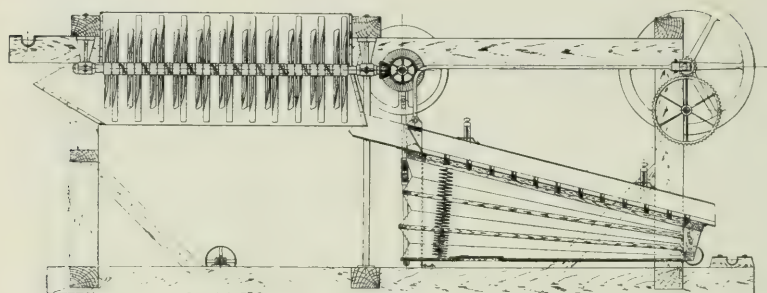
acter are provided with bellows, to produce an artificial air current, in order to blow away the finer worthless material. One of the most effective of these contrivances, I believe, is "Wood's dry placer-miner,"* manufactured by Messrs. Fraser & Chalmers.

Usually in such machines the bellows and sieves are worked in synchronism, being coupled together and driven by belting by means of a fly-wheel turned by hand. A machine of this sort, which weighs,

*A large size machine requires two horse-power to operate it, and is mounted on an oak frame which covers a ground space of 5 feet by 13 feet 9 inches, weighs 2,600 pounds, and is stated to have a capacity of 10 cubic yards of dry screened gravel per hour, the gravel being fed to the machine from a disintegrating-box filled with revolving steel blades. The riffle-board has a shaking motion of 150 strokes per minute, which helps to settle the gold to the bottom, and the blast of the bellows can be regulated so as to make it stronger or weaker. The prospecting machine has a length of 4 feet, width of 2 feet, and height of 3 feet 10 inches; weighs 300 pounds, and its capacity is given as 1,500 to 2,000 pounds per hour.



HANNAN'S FLAT AT KALGOORLIE. THE SCENE OF MUCH SUCCESSFUL DRY BLOWING.
By courtesy of T. A. Rickard, Esq.



WOOD'S DRY PLACER MINER. SECTIONAL VIEW SHOWING CRUSHING, SHAKING, AND BLOWING ARRANGEMENTS

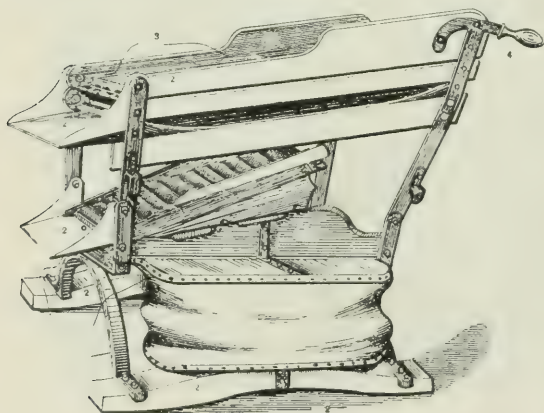
Fraser & Chalmers, Chicago, Ill., U. S. A.

according to Mr. Rickard, 124 pounds, and puts through 10 to 14 tons a day, costs in Freemantle about £16, and can be carried on poles by a pair of men.

A little machine known as the "pneumatic prospector," made by P. P. Cuplin, of West Bend, Iowa, might possibly be worth the attention of prospectors. It measures 6 by 11 by 14 inches and only weighs 10 pounds; it seems extremely portable, and is said to give a clean prospect, equal to careful panning.

A larger machine, called a "pneumatic separator," which weighs 160 pounds, it is claimed, is able to handle 20 to 30 cubic yards of gravel per day, and to save fine and coarse gold and nuggets of any size, free from black sand.

The Cement Deposits.—Leading, as they have done, to the discovery of the more valuable "formations," in consequence of the fact that these latter did not outcrop at the surface (on account of the comparative softness of the lode material), the cement-deposits may be regarded as of the very greatest importance, in particular in this field, notwithstanding that the amount of gold they have returned in the aggregate



LORDEN'S DRY-BLOWING MACHINE.



The cuts on this page are reproduced by courtesy of T. A. Rickard, Esq.

gate is comparatively trifling. Underlying the red loam on the flats, which covers extensive areas, a considerable thickness of blue clay is met with in places, whilst on the outskirts of the hills surrounding them it is only of slight thickness and rests directly on the auriferous series.*

The first discovery of cement† was made some 3 or 4 miles south of the earlier alluvial find, near what is now known as the "Boulder Township," where the prospectors found rich patches of surface-dirt and cement and located several strong quartz croppings, on the strength of which the Great Boulder and other leases were pegged out.

These quartz veins were larger than those previously referred to at the north end of the field, but turned out equally poor and uncertain, and it was ascertained by sinking a shaft, known as No. 3, or Gamble North's, in the eastern part of the Great Boulder ground, that the vein pinched at a depth of 75 feet. A trench was then started to cut a big iron-stone outcrop, which forms a hillock behind the present company's office, but the iron-stone reef was found to carry only about 12 pennyweights of gold per ton, which was too low-grade in those days to pay. This trench, when extended further west, however, penetrated another vein, which had no outcrop visible, but proved to be the cap of the eastern portion of the magnificent lode, which has been worked up to the surface. The formation, as shown in this open-cut, was nearly 20 feet in width, buried under some $2\frac{1}{2}$ feet of cement.

The Great Boulder Perseverance had a somewhat similar beginning. The vein in the old No. 1 shaft turned out poor and was abandoned, but the rich formation that traverses the adjoining Lake View Consols Lease was found later on, capped with cement, which concealed its existence, and it has since been stoped to daylight in the huge open cutting depicted on the opposite page.

At the beginning of 1898, great excitement was caused by the pegging out of a number of claims on the Ivanhoe Venture Lease, by Bray and party and other alluvial men, and in the course of the year 639 ounces 5 pennyweights were obtained from some $247\frac{1}{2}$ tons of cement crushed.

What may also prove, perhaps, an important find was made in May, 1899, in the northern part of the field on Lease 1,260 E, on the property of the Kalgoorlie Mining Developments Co., Ltd., where the first

* H. P. Woodward. *The So-called Lode Formations of Hannan's and Telluride Deposits.* Op. Cit. p. 6. *Trans. Inst. of Mining and Metallurgy*, 1897, p. 15.

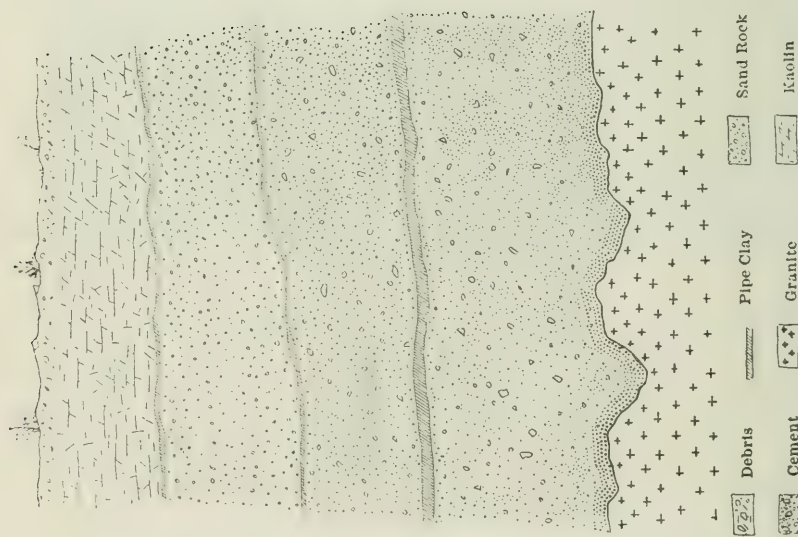
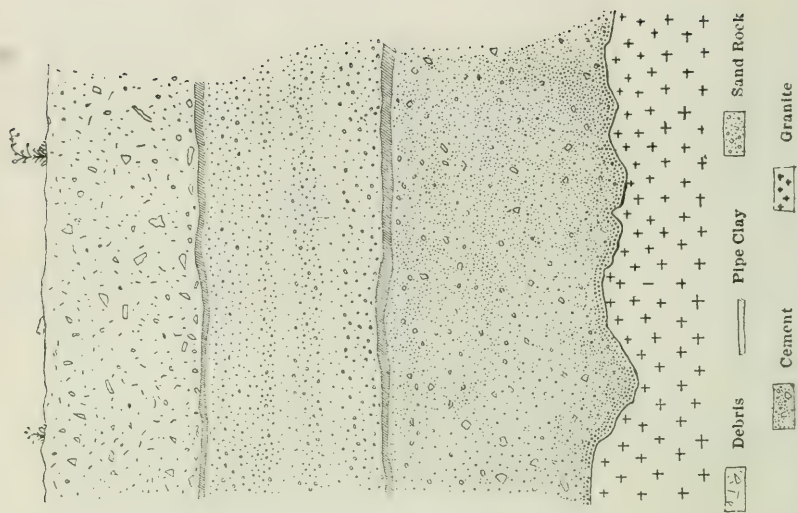
† T. A. Rickard. *The Minerals Which Accompany Gold and Their Bearing Upon the Richness of Ore Deposits.* *Trans. Inst. of Mining and Metallurgy*, 1808, p. 207.



OPEN CUT, GREAT BOULDER PERSEVERANCE MINE.

shaft sunk (known as No. 1), bottomed on an iron-stone "wash" (mixed with pug and concretionary nodules of calcite), about 10 feet thick, at a depth of 82 feet. Other shafts sunk in this lease have proved the existence of a gutter of cement running apparently in a northeast and southwest direction at a depth of about 105 to 108 feet. This cement averages about 2 feet in thickness, whilst the pay-channel so far varies in width from 12 feet to 31 feet 6 inches, and prospects from 15 pennyweights to an ounce and a half.

Three claims located upon it up to the end of December, 1899, produced as follows:



SECTIONS IN THE OPEN CUTS AT KINTORE.

By courtesy of T. A. Rickard, Esq.

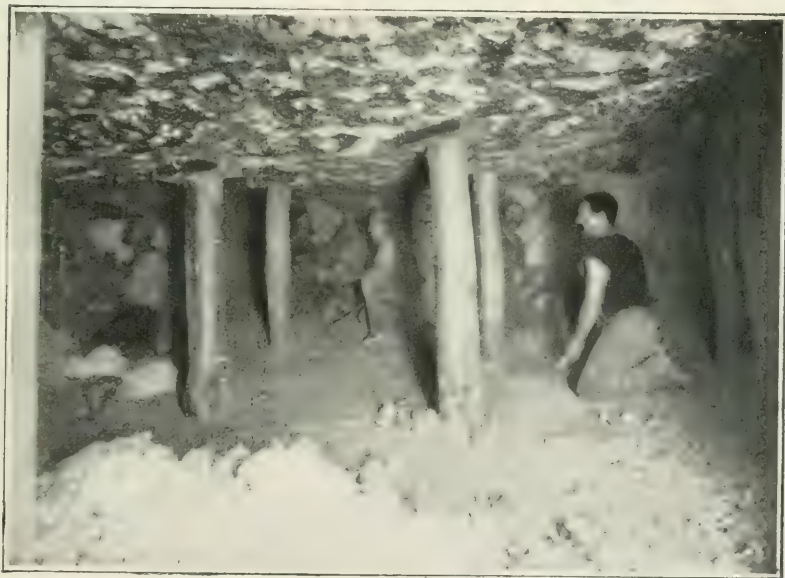
(1) 444 tons of cement crushed yielded 608 ounces 14 pennyweights 12 grains of gold.

(2) 429 tons yielded 427 ounces 6 pennyweights 20 grains.

(3) 350 tons 10 hundredweight yielded 486 ounces 11 pennyweights 6 grains.

The bullion varies in value from £3 18s. 6d. to £4 1s. per ounce.

Several strong outcrops have also been uncovered in course of working, one of which carries a dark bluish quartz, and from the number of angular pieces of rich "float" of a similar description that have been found it appears not unlikely that following this lead up may result in the discovery of a payable reef, or reefs, in this section of the field. The cut on this page, from a view taken underground in these workings, affords an excellent representation of the way in which mining is carried on in deposits of this nature.



WORKINGS NO 1, ALLUVIAL CLAIM, KALGOORLIE.

Topographical Features of the Field.—Hannan's Belt, as it is frequently called (in the centre of which Kalgoorlie is situated), is a long, narrow strip of country, some 8 or 10 miles in length, folded along an axial line which runs in a northwest and southeast direction and has a width of about 2 miles. In the northern half of this district, a number of leases have been taken up at various times, on quartz lodes which have hitherto proved of little or no value, whilst the group of mines which have rendered the district famous are of a totally distinct char-

acter and lie about 4 miles southeast of Kalgoorlie, in the immediate neighbourhood of the Boulder Township, before referred to.

All the richest mines at the southern end of the field are grouped around the flanks of an isolated ridge* and several conical hills of about the same height to the southwest of it, which break up the prevailing level of the surrounding flats; so that, proceeding from Kalgoorlie along the Boulder road, you gradually though slowly ascend, until you reach the foot of the Australia Hill—the ridge referred to. The north end of this ridge (which is occupied by the Kalgoorlie lease), passes southward through the Associated, Lake View, and Lake View South leases, and springs rapidly up from 150 to 200 feet above the rising ground surrounding it.

I lay stress on this feature of the topography, because it seems to me probable that these hills (the summits of which were, many of them covered originally with ironstone-gravels, passing in places into compact limonite), mark the principal centres where, through the pressure of the underlying plutonic rocks, or volcanic agency, the main series of igneous eruptives (that form such an important feature of this section of the field, and to which the telluride deposits seem to owe their origin), burst their way through to the surface, and owing to their superior hardness have since escaped being leveled by denudation.

The direct effect of these subterranean disturbances where they were most active may well have been to crumple up, fault, and elevate the rocks in the neighbourhood, and it is probably, therefore, owing to this fact that the largest and richest ore-bodies found have been discovered on or in the neighbourhood of the broken hilly ground above referred to, which dominates the surrounding central portion of the basin, running in a direction more or less parallel with and midway between the longer axes of the main folds that hem it in on the east and west. South of this metalliferous area, the general level of the basin falls gradually towards Hannan's Lake, a large depression or clay-pan, in which water is only seen after a heavy rainfall, which is of rare occurrence; though a considerable quantity of salt water is conserved in the alluvial sands and clays which fill its bed.

My next paper will be devoted to the water problems which are met in the Australian gold-fields—the peculiar difficulties of the region and the means of relieving them.

* NOTE.—This ridge is not of uniform height, however, being crossed by several "necks" which divide it into a series of "hogs-backs."

INFLUENCE OF THE EXPOSITION ON THE FRENCH IRON AND STEEL INDUSTRY.

By Henri Guérin.

France has two distinct claims upon the interest of iron and steel producers—first, that conditions have always imposed upon French iron masters the closest study of economy; second, that she is a consumer of iron and steel, and therefore a profitable study for the countries exporting those materials. M. Guérin was for twelve years closely interested in the production of structural materials in France, and hence is master of his subject.—THE EDITORS.



THE industry of iron and steel in France may be said to have commenced its real development with the first French exposition of 1855, and a gradual progress was shewn at the successive expositions of 1867, 1878, and 1889; but at the present time the industry has taken a veritable boom. There is no doubt that especial efforts were made at the exposition just closed, and the remarkably fine exhibits of the various establishments were the results of the ambitious competition of leaders in the metallurgical industries.

The natural mineral riches of France are hardly such as to enable her to compete with other more favoured countries in the production of cheap pig iron, or to introduce the most recent devices invented for its manufacture; but the extreme care which her manufacturers and scientists have given to all the details of their work has produced important results. As we shall see further on, each international exposition, and especially the international exposition of 1900, has marked a period of prosperity in the siderurgical industry.

In order to grasp the present conditions, it seems advisable to recall briefly some of the preliminary features of the processes of the manufacture of iron and steel, and to emphasise particularly the most interesting facts which have been manifested at the epochs of the successive expositions. After this brief *résumé* the reader will be better prepared to judge of the progress evidenced by the exposition of 1900. Having thus examined the purely technical side of the subject we shall then be in a position to discuss its economic features, and be able to formulate certain conclusions which follow.

The early metallurgists commenced by producing iron directly in a low furnace, using the richest and most fusible ores, together with

natural fuel. Later on came the introduction of the high furnace, permitting the production of wrought iron indirectly, that is, by first making cast iron. In the higher furnaces wood was replaced by coal, alternate layers of ore and fuel being used, and a much greater product was obtained from the ore. By means of improvements in the blast, higher temperatures were produced, and, by creating the most favourable conditions for effecting the combination of oxygen and carbon, the reduction of the iron from the ore became more and more complete and economical. The fused iron being run directly into the sand was allowed to cool in the form of pigs. The pigs were then treated in refining furnaces in which the combined carbon was separated by oxidation, producing blooms ready for the operations of puddling, rolling, and forging. If it is not desired to produce wrought iron, the pigs are remelted in the cupola for the production of castings. The product of the cupola is also used as the material for the production of cast steel, as we shall see hereafter. Steel is also produced by the carbonisation of wrought iron in special furnaces, the product being called cemented steel, but the processes most generally employed at the present time are based upon the decarburisation of cast iron, the methods being modified according to the resistance and elasticity desired in the product. Without going into further details of the elementary principles, the displays at the various expositions will now be considered.

The most conspicuous novelty shown at the exposition of 1855 was the employment of the discharge gases from the blast furnace for heating the blast; especial attention being directed to this subject in the discussions at that time as constituting a new and important advance in the utilisation of heat formerly wasted. In 1855 also appeared improvements in rolling-mill construction which enabled rails and structural sections in wrought iron to be produced to an advantage which, while not comparable with the present methods, was nevertheless a marked advance over previous processes. The Creusot works and the Petin-Gaudet works at that time made their first attempts at the manufacture of armour plates of steel. There were also exhibited some important examples of steel forgings, notably a cranked axle for a locomotive. It may be noted that at this period the only methodical attempts at testing were a few instances of impact test.

At the following exposition, in 1867, a much more complete display was made. The conspicuous feature was the prominence given to the then newly-introduced Bessemer process for making steel. This process consisted in the decarburisation of cast iron by means of

a powerful blast of air blown through the molten metal in a peculiar form of vessel known as a "converter." Examples of this steel in the form of rails were exhibited by the establishments of Imphey, Petin-Gaudet, and Terre-Noire. At that time the importance of a knowledge of the chemical composition of pig iron and its bearing upon the product became realised. This was followed by the introduction of testing methods for determining the resistance and elongation of the material. The Bessemer process gave satisfactory results only after it was modified by the addition of manganiferous iron at the close of the operation, and by the use of irons carefully selected with regard to their freedom from phosphorus and sulphur. These early undertakings marked a new era and a fresh starting point for the work of metallurgists. At this time also the importation of high-grade ores into France from Algeria and from Spain was inaugurated, and at the exposition of 1867 were shown some remarkable examples of iron and steel forgings, especially for military and naval purposes.

In 1878, at the next international exposition, it might have been supposed that the disastrous effects of the war of 1870 would have been apparent in a retardation of metallurgical progress; but no such effect was evident, the displays at the exposition showing that in preparing for it the various establishments had exercised especial efforts to regain the lost time. The result was admirable, for the metallurgical exhibits in 1878 not only demonstrated the immense advance which had been made in the metallurgical arts in the short period which had intervened since the previous display, but were also prophetic of the immediate progress which followed.

The new process for the manufacture of steel introduced at the exposition of 1867 caused an increased demand for the production of pure pig iron at a moderate cost. This stimulated the development of the blast-furnace improvements, especially appearing in the design of apparatus for the production of the hot blast, among which may be mentioned the devices of Siemens, Cowper, and Whitwell; the use of these resulting at the same time in a reduction in manufacturing cost and an improvement in quality of product. The Firminy works, as well as those at Terre-Noire, took the initiative in the production of sheet steel by the Siemens-Martin process, this offering the advantage of producing a steel of high degree of elasticity and uniformity, and at the same time permitting the use of an ordinary grade of pig iron.

At this exposition appeared also steel castings, both hard and annealed, from patterns, as well as malleable-iron castings. Many

heavy forgings were also exhibited, including steel armour plate, the demands for such work influencing the construction of an important tool, the 100-ton steam hammer, the whole being in response to the demand for heavy steel work for ordnance purposes.

While the exposition of 1878 was the occasion of the display of a new industry in the development of the open-hearth process, that of 1889 showed the results of improvements made in the Bessemer process. By modifying the character of the lining of the converter (the Thomas-Gilchrist process), basic steel was obtained, this method furnishing the long-sought process of dephosphorising pig iron. Two millions of tons of basic steel represented the production of the whole world, the Department of Meurthe and Moselle in France furnishing 200,000 tons. The Siemens furnace was also greatly improved, the roof being constructed of highly siliceous bricks and the sole covered with basic material.

The conspicuous feature of the exposition of 1889, however, was the production of metallic alloys both in the high furnace and in the crucible. In 1867 the proportion of manganese in the spiegeleisen rarely exceeded 8 to 10 per cent., while in 1878 a content of 88 per cent. was reached. In 1889 alloys of iron with chromium, silicon, and manganese were shown. One alloy, made at the Holtzer establishment, contained 80 per cent. of chrome and 10 per cent. of carbon. In the blast furnaces at Marseilles the maximum proportion attained in the respective alloys were 65 per cent. of chrome, 54 per cent. of silicon, and 89 per cent. of manganese. In regard to the industry of steel castings, the principal novelty at the exposition was the small converter used in connection with the Robert process, by which a great number of small castings could be made without the necessity of installing a full-sized Bessemer plant. It is probable that the era following the exposition of 1900 will witness the erection of many new steel furnaces of this type.

The improvement in the elastic quality of steel, originating at this period, has produced remarkable results. In the exhibit of the Firminy works were shown examples of mild steel, having a resistance of 40 kilogrammes per square millimetre (57,000 pounds per square inch), with an elongation of 30 to 35 per cent. Engineers began to perceive that it would now be possible to use steel plate in the construction of steam boilers with safety. Steel wire was also shown at the exposition of 1899 by the Châtillon-Commentry works, some of the exhibits being remarkably fine. Armour plate and war material generally formed also a conspicuous feature of the exposition.

showing especially the progress realised by the employment of the alloys of steel with other metals.

To complete this review of the exposition of 1889 a statement is appended showing the quantity of cast iron, wrought iron, and steel used in the construction of the various buildings of the exposition; this serving as a point for comparison with the similar use of material in connection with the exposition of 1900:

Building.	Weight of material, metric tons.
Palace of Machinery	12,761
Palace of Fine Arts and Liberal Arts.....	8,027
Palace of Diverse Industries	8,337
Central Dome	1,091
Pavilion of the City of Paris	180
Gallery of Class 61	135
Gallery of Agriculture	789
Palace of Alimentary Products	173
Pavilion of the Ministry of Public Works	152
Pavilion of State Manufactures	57
Palace of the Colonies	58
Eiffel Tower	7,347
Total	39,107

The exposition of 1889 seemed to have demonstrated that all the efforts to produce iron and steel in great quantity and at the same time of excellent quality had resulted in the maximum output, but the exposition of 1900 far surpassed all its predecessors in this respect. Space is here lacking to enter into all the details of the various exhibits, and only the three principal lines of work can be examined successively. These leading features are:

1. The development of the basic process of making steel.
2. The increased use of the Siemens-Martin furnace.
3. The tendency to substitute steel castings for iron castings and forgings.

The production of steel by the Thomas process, commonly known as the basic process, has quintupled since the exposition of 1889, while the output of the acid process has only doubled. This increase is partly due to the introduction of the "mixer," which, as its name indicates, acts by the mingling and consequent regulation of the charges of cast iron in such a manner that the sulphur, which would interfere with the quality of the steel, gathers on the surface of the liquid metal as a sulphide of manganese. Besides this it has been demonstrated that coke, introduced directly into the steel, produces

a hard steel, highly carburised and free from manganese, well adapted for the production of rails by the Thomas process. Finally, the slag and waste products of the process form valuable fertilisers because of their richness in phosphoric acid.

The Siemens-Martin furnace possesses the advantage of great adaptability, and it is not rare at the present time to find such furnaces of 45-tons capacity. Still further, the Bertrand-Thiel process employs two basic furnaces, of which the upper one is used for the elimination of the silicon and the phosphorus, the decarburisation being effected altogether in the lower one.

Steel castings made their appearance in 1889, but their employment was very limited because of high temperatures demanded, because of the great shrinkage, and because of the numerous blow holes which appeared in castings above a moderate size. At the present time these difficulties have been overcome, as could readily be seen in the specimens shewn at the exposition. Three processes have been employed in the production of steel castings: 1. The crucible method, which has been improved by the use of judicious additions of nickel, aluminum, etc., to the product; 2. The use of a special form of Siemens-Martin furnace adapted to the production of large castings, enabling either hard or soft castings to be made. The following notes concerning these products were presented by M. Tissot at the Metallurgical Congress of 1900:

Percentage of carbon in steel	0.25 to 0.50
Percentage of manganese in steel	0.40 to 1.00
Percentage of silicon in steel	0.20 to 0.45

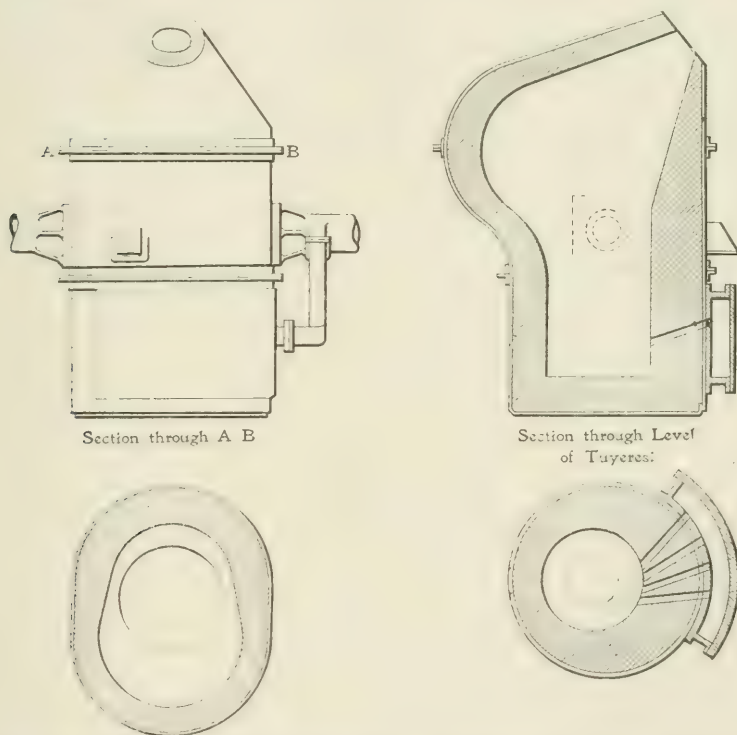
Tests.	Soft Steel, Basic.	Soft Steel, Acid.	Hard Steel, Acid or Basic.
Resistance to tension	64,000 lb.	70,000 lb.	110,000 lb.
Percentage of elongation ..	25 to 28	25	8 to 12
Impact resistance	42,500 lb.	28,500 lb.	10,000 to 11,000 lb.

The drop test consisted of a ram of 18 kilogrammes weight (about 40 pounds) falling from a height of 2 metres (6 ft. 6¾ in.) upon bars of 30 × 30 mm. (1.18 inches × 1.18 inches) spaced 160 mm. (6.3 inches) between supports.

3. The use of small converters. The Robert converter, already referred to as having appeared in 1889, gives a milder steel than that produced in the Siemens-Martin furnace. By this method steel having a resistance of 57,000 pounds and an elongation of 35 per cent., to a steel of a resistance of 114,000 pounds and an elongation of 7 to 8 per cent., can be made. Steel of this kind has been used for the bodies of electric generators, of which numerous examples were found at

the exposition. The composition showed a content of carbon, 0.14 per cent.; manganese, 0.34 per cent., and silicon, 0.06 per cent.

Another form of converter, patented by T. Levaz, has been used by the Société des Aciers de la Meuse, at Stenay, who exhibited steel castings for the frames of bogie trucks for electric tramcars, gear wheels, clutches, a hydraulic motor 3 metres in diameter, engine castings, cranked axles, and also furnished the frames of many of the generators shown in the department of electricity.



THE LEVAZ CONVERTER, FOR MAKING SMALL CASTINGS DIRECT FROM THE CONVERTER.

A sketch of this converter is given, and it appears to possess many advantages. The pocket formed in the upper portion is intended to receive the product at the close of the operation, and permits an intimate mixture of all the molecules of the steel with the various materials which may be added. These converters are made of a capacity of 1,600 to 1,800 kilogrammes (3,500 to 4,000 pounds), and the average duration of the blow is about 12 minutes. The arrangement of the tuyeres, as shown in the sketch, imparts a rotary motion to the

charge, well adapted to secure a thorough mixing. As an example of the advantages of the use of steel castings in construction it is only necessary to refer to the voussoirs used in the arches of the Alexander III. bridge, this structure containing no less than 2,500,000 kilogrammes of steel castings. It was the use of this material which made it possible to solve the problem of constructing a single arch across the Seine which should afford an unobstructed waterway for navigation and at the same time avoid elevating the roadway to an extent which should interfere with the perspective of the esplanade of the Invalides. The employment of steel voussoirs permitted the construction of the very flat arch without requiring undue thickness at the key.

It would exceed the limits of the present discussion to go further into details of individual exhibits. It is only necessary to mention the improvements in tools made possible by the use of chrome and tungsten, the manufacture of seamless tubing, the rolling of weldless tires, the many artistic castings, the variety of drop-forgings, the military and naval material, the 50-ton electric locomotive of Creusot, etc.

We may complete this enumeration by giving, from special information furnished by the management of the exposition, the classified weights of metal construction work used in the buildings of the exposition of 1900, and in the Alexander III. bridge.

Structure.	Weight, in metric tons.
Large Palace of Fine Arts	15,803
Small Palace of Fine Arts	616
Palace of Horticulture	770
Monumental Entrance	188
Lower Palace	711
Palace on Fabert side	1,596
Palace on Constantin side	1,433
Palace of National Manufactures	2,083
Rearrangement of the Palace of Machinery	2,129
Palace of Electricity	4,449
Palace of Chemical Industry	2,399
Palace of Mechanics	2,963
Palace of Civil Engineering	4,560
Palace of Textile Fabrics	4,687
Palace of Education	1,815
Palace of Mines	2,514
Alexander III. Bridge—	
Steel Castings	2,359
Structural Rolled Steel	2,823
Cast Iron	270
Temporary Erecting Works	400
Total	54,568

It is only necessary to mention also the important public works involving a great amount of metallic construction and directly resulting from the exposition; these are:

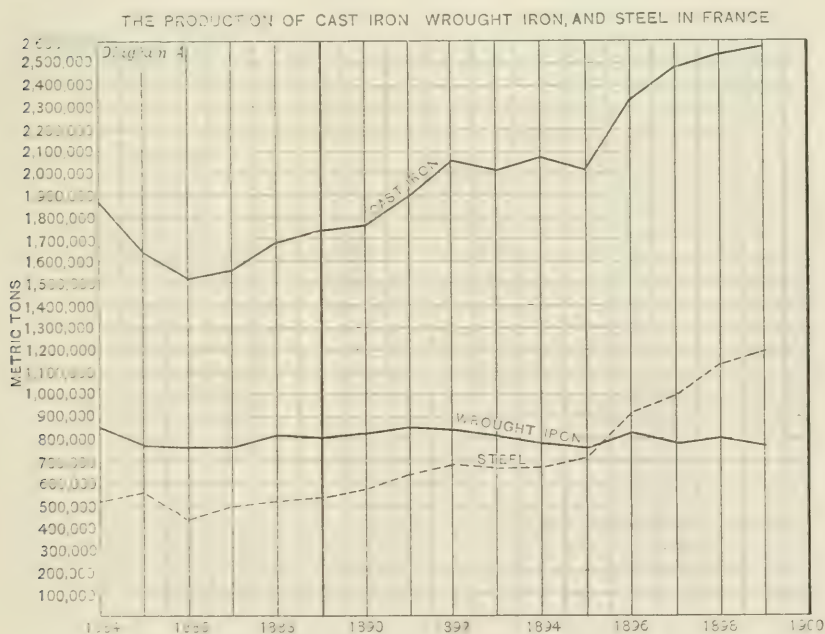
1. The Metropolitan Railway of Paris (first portion only constructed).

2. The new lines of the Western Railway of France.

3. The prolongation of the Orléans railway on the Quai d'Orsay.

Having thus generally reviewed the state of the industry of iron and steel manufacture in France, it will be appropriate to examine the economic and statistical side of the subject.

In order to form a correct opinion of the prosperity of the siderurgical industries of a country, the best index to consult is the production of cast iron. The tonnage of cast iron produced in France has risen from 1,528,246 tons in 1878 to 2,534,427 tons in 1898; an increase of 1,006,181 tons, or 66 per cent. The total production of steel has risen from 269,181 tons in 1878 to 1,138,633 tons in 1898. This increase is partly explained by the introduction of the Bessemer and Siemens-Martin processes.



As will be seen upon examination of Diagram A, the production of wrought iron has remained stationary, or even declined, during a number of years, while the output of steel increased, and in 1895 passed that of wrought iron. As is well-known, the first patents of Thomas for basic steel were taken out in 1875. It was in 1880 that

Year.	Metric Tons.		Wrought Iron.	Steel.
	Cast Iron.			
1885.....	1,630,648		782,431	553,839
1886.....	1,516,574		766,550	427,589
1887.....	1,567,622		771,610	493,294
1888.....	1,683,349		816,973	517,294
1889.....	1,733,964		808,724	529,302
1890.....	1,762,196		825,369	581,998
1891.....	1,897,387		833,409	638,530
1892.....	2,057,258		828,519	682,527
1893.....	2,003,096		808,171	664,032
1894.....	2,069,714		785,781	674,590
1895.....	2,003,868		756,793	714,523
1896.....	2,339,537		828,758	906,817
1897.....	2,484,191		783,966	994,801
1898.....	2,534,427		801,543	1,138,633
1899.....	2,567,888		842,775	1,253,701

PRODUCTION OF CAST IRON, WROUGHT IRON, AND STEEL IN FRANCE.

These are the figures represented in graphic form on page 1051.

the process was practically introduced into France, when 4,771 tons of steel were produced, while the product in 1892 was 287,528 tons, and at the end of these 12 years the total quantity of basic steel produced was 1,820,672 tons. The following table will show the increase in the production of steel rails and the corresponding diminution in the production of iron rails.

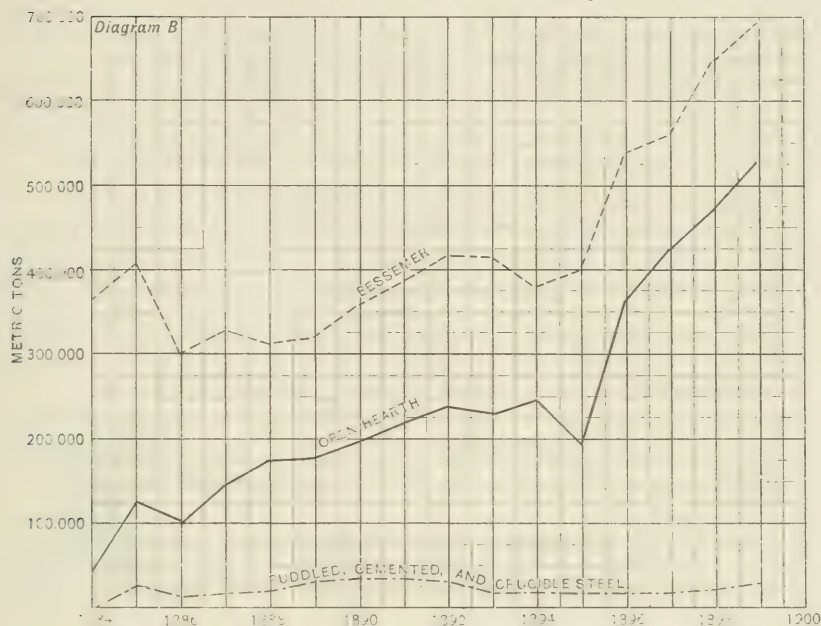
Year.	Metric Tons.		Year.	Metric Tons.	
	Steel Rails.	Iron Rails.		Steel Rails.	Iron Rails.
1869.....	50,025	133,403	1883.....	340,679	655
1870.....	38,275	81,363	1884.....	284,031	.....
1871.....	18,063	77,985	1885.....	249,416	.....
1872.....	52,199	103,963	1886.....	170,595	.....
1873.....	64,097	130,531	1887.....	108,898	.....
1874.....	102,227	125,664	1888.....	93,868	.....
1875.....	120,660	96,886	1889.....	58,096	.....
1876.....	130,681	57,935	1890.....	66,844	.....
1877.....	137,147	43,880	1891.....	112,857	.....
1878.....	190,240	39,232	1892.....	163,840	.....
1879.....	202,434	27,604	1893.....	199,328	.....
1880.....	191,776	16,777	1894.....	110,609	.....
1881.....	231,334	8,064	1895.....	85,249	.....
1882.....	284,069	6,930	1896.....	77,104	.....

THE PRODUCTION OF IRON AND STEEL RAILS IN FRANCE.

After the exposition of 1889 the railway companies began to use heavier rails, weighing 40 to 45 kilogrammes per metre (80 to 90 pounds per yard). The exposition of 1900 has shewn no similar tendency, the effort being toward an improvement in quality rather than an increase in weight. Thus among the exhibits of the steel works of Longwy was shown a rail of 43 kilogrammes per metre (82 pounds per yard) which gave under test a resistance of 89 kilogrammes per square millimetre (126,588 pounds per square inch) with an elongation of 13 per cent.

The remarkable increase in the production of cast iron and steel

THE PRODUCTION OF STEEL IN FRANCE



Year.	Metric Tons.				
	Bessemer.	Open Hearth.	Puddled and Forged.	Cemented.	Crucible.
1884.....	305,436	40,910	.....	.....	.....
1885.....	404,019	123,829	11,746	6,948	7,297
1886.....	300,165	101,406	9,837	1,512	6,384
1887.....	324,487	143,764	12,532	1,491	7,532
1888.....	310,012	172,487	13,118	1,342	9,409
1889.....	316,892	179,000	13,689	1,598	12,681
1890.....	354,194	193,189	16,382	1,301	13,377
1891.....	388,256	216,168	16,046	1,455	12,135
1892.....	412,534	238,224	13,129	1,385	11,500
1893.....	410,619	228,642	7,270	1,319	11,168
1894.....	377,976	248,369	6,958	1,238	10,968
1895.....	399,139	191,682	6,685	1,292	10,985
1896.....	534,995	359,543	6,892	1,347	10,249
1897.....	557,708	415,186	8,012	1,186	10,091
1898.....	646,550	460,617	6,672	1,110	15,411
1899.....	697,053	520,476	8,015	1,041	17,067

THE PRODUCTION OF STEEL IN FRANCE.

Presenting in tabular form the same data shown graphically above.

shown in Diagram B, beginning in 1895, is due not only to the improvements introduced in methods of manufacture, but also to the influence of the exposition of 1900 and of works undertaken in view of the exposition. It is interesting to note that a similar effect appeared at the approach of the exposition of 1889, the rise being evident

in 1886, although naturally less-marked than in the later case. In each instance the rise in output followed a previous decline, the advent of an exposition having proved sufficient to effect the change.

The influence of the exposition from a commercial point of view is manifest. According to data furnished by the Chamber of Commerce, the importations in 1887 classified under machinery and mechanics amounted to 43 millions of francs; in 1898 it passed 77 millions, and in 1899 it reached 89 millions. A similar increase is found in diverse products of metal, the importation rising from 23 millions in 1888 to 33 millions in 1899. The decline shown on the diagrams between the years 1892 and 1895 corresponds to the period of financial crisis, due to overproduction, which appeared in nearly all productive countries. This effect, however, was much more marked in Germany, England, and Belgium, than in France, where the output is much more carefully regulated with regard to internal consumption.

With regard to the question of prices, while the price of steel rails was 136 francs per ton in 1897, it has to-day reached nearly 200 francs, or about what it was in 1880. Nevertheless this rise, which began to appear in 1898, has not checked the demand, which has continued to develop.

In conclusion, it appears evident that the general effect of international expositions in France has been to develop a spirit of active competition, while the comparisons which are apparent when the efforts of this competition appear in exhibition give a very definite indication of the general direction in which advance has been made.

Apart from the direct effect of competition it may be observed that a result of the exposition of 1899 was the creation of modern laboratories for testing and research, which have paved the way for many of the advances since made, especially in connection with the various alloys which have done so much to further improvements in the manufacture of steel.

The exposition of 1900 showed the tendency of metallurgists to devote nearly all their attention to improvements in the production of steel castings. In view of the results which have been attained already in this branch of the art, so far as resistance and elongation are concerned, there is every reason to believe that this material will enter into the field of general structural work and probably cause great modifications in the art of metallic construction.



ACTUAL WORKING OF AMERICAN LOCOMOTIVES ON BRITISH RAILWAYS.

By Charles Rous-Marten.

A great deal has been said of the British builders' loss by orders placed with American firms for engineering work in Britain or her colonies. Very little has been said of the enormous gain to British trade and British investors from American ability to step into the breach, and to supply the materials, the tools, or the machinery which England's vast progress demanded and her overcrowded workshops could not supply. The purchase of American engines was purely a question of expediency; the working of the American engines is a study of the utmost utility to both nations. It is this practically valuable aspect of the matter that Mr. Rous-Marten considers.—THE EDITORS.



It will be remembered, in the July, August and September numbers of THE ENGINEERING MAGAZINE, in 1899, I dealt at some length with the difference between American and British principles and methods of locomotive building, in special relation to the orders which had been given by certain British railways for engines built in America. I then hoped to be able long ere this date to furnish some definite information as to the working of the American engines on the English railways which had ordered them at a time of strain and stress among the British manufacturing firms. But I have found it most difficult to obtain any specific data. In some cases my request for particulars has been most courteously but firmly refused, on the ground that the period was still "too previous" for any satisfactory conclusions to be announced. In other instances the matter was postponed indefinitely. So I am once more compelled to treat this subject from the standpoint of the independent observer, rather than from that of the "official report" supplier.

Privately I have taken a good many opportunities of noting the class of duty allotted to the American goods engines, and of observing how they *appeared* to perform their duty, and of seeking the opinion of their drivers as to their general efficiency. So far as could be judged from outside observation, the imported engines seemed able to take their turn quite satisfactorily with those of home construction and practically to do just as well. It is significant that recently the Americans have been put on one important class of work with freight trains which involves much faster running than that of the ordinary goods trains, while heavy loads—as loads are regarded in England—have to be hauled. This is apparently a distinct testimonial to their

efficiency. As for the drivers, they have had to overcome the chronic British prejudice against novelty of any kind, but now that they are getting used to handling an unfamiliar type of machine, they seem fairly well-contented with the American engines, making due allowance for the normal British habit of grumbling.

On the other hand, there has been a noticeable tendency in some quarters to "run down" the strangers, or—what is perhaps worse—to apologise for them and to explain that it was necessary to procure them, in spite of their shortcomings, to keep abreast of the traffic.

Probably the explanation of some adverse utterances may be found in the fact that the step taken by the companies in ordering the locomotives from abroad was an exceedingly unpopular one. The feeling of the British public generally was distinctly hostile, excepting only in the case of that section not only interested in the traffic which the engines were imported to facilitate, but also intelligently aware of the extent to which it would benefit through the non-detention of the goods in transit. The public generally, and the manufacturing and labouring public in particular, felt very strongly that, however badly the railway companies needed the engines, if the British makers were too busy to supply them the railways ought to wait patiently until they could get what they needed, and that it was disgracefully unpatriotic to go abroad for what could be made, sooner or later—especially later!—in Britain. Such a sentiment is apt to influence electoral votes. Most railway chairmen and directors are members of Parliament. Most members of Parliament are shareholders in railways. All are interested in politics. A matter like this large importation of foreign locomotives was apt to be brought forward at the general election, which has been pending for more than a year past, to the prejudice of those persons concerned, directly or indirectly, in the transformation. Therefore it clearly behooved those persons in their own political interests to lay all possible stress on its essentially makeshift character, and to avoid any defence on the basis of the importations having proved as efficient as the home-make.

In these remarks I am not pointing to anybody in particular. I am simply enunciating a fact. I declare unhesitatingly that it would have been most unpopular to assert or even admit, on the eve of the late general election, that these imported American engines could possibly be so good as British-built machines. Even through recording frankly the splendid work done under my own independent observations by the newest French locomotives I incurred strong personal unpopularity in certain quarters and received quite a collection of abusive

anonymous letters. Thus does national prejudice and miscalled "patriotism" enter into such a purely practical and scientific question as that of locomotive efficiency. It is droll, yet it is also most unfortunate in the true interests of the public in general and of the railway companies in particular.

But there is, of course, another side to the present question. It is quite certain that the American engines have laboured from the outset under one most serious disadvantage, wholly apart from that attaching to the insular prejudice of drivers and foremen. And this consists in the fact that they are not the sort of engines that American engineers or builders would have designed for the class of work they are put to. I do not wish to be misunderstood. I am casting no reflections on either British or American designers. I simply say that they view the requirements of traffic from different standpoints, and that a British engineer, keeping in mind the precise local requirements of British goods traffic and the special features of British methods and materials of construction, would design for a given class of duty an engine totally different from the one which an American engineer, bearing in mind the precise local requirements of *American* freight traffic and the special features of *American* methods and materials of construction, would design under the like conditions. No one who knows anything of American ways will contend that, had every point excepting the extreme dimensions been left to the Baldwin and Schenectady companies respectively, those builders would have constructed for the specific duty the same type of locomotive as that which they turned out to the order of the British railway companies. As it was, they had to do the best they could under stringent conditions.

While the highest official authorities still prefer to maintain reticence as to the relative performances of the American engines, it has been possible to glean a good deal elsewhere as to their working. After collating much independent information, I gather that they do their work well and satisfactorily, except that they burn more coal than the British locomotives employed on similar work. The question of repairs is still in the future, but as to the matter of coal consumption there is, I think, little doubt that that of the American engines is somewhat higher than that of the British machine. And the excess, if it really do exist, may very probably be attributable in a large measure, if not wholly, to the fact touched upon just now, that these engines do not represent the matured result of American experiences as applied to this particular type of locomotive designing. I may at once say frankly that even were the details of coal consumption

accessible they would not impress or even interest me. The experience of that memorable discussion, or rather dispute, before the Institute of Civil Engineers at the conference of 1899, constituted an amusing object-lesson as to the value of coal-consumption returns even when presented by some of the most eminent living mechanical engineers. The discrepancies were so hopelessly irreconcilable as to amount virtually to absolute contradictions.

So far the only definite report upon the working of the American goods engines in England that to my knowledge has been published is a brief memorandum from Mr. S. W. Johnson, chief mechanical engineer of the Midland Railway, furnished in response to an enquiry by the board of directors as to the result of the experiment of importation. In this memorandum Mr. Johnson says: "The whole of the forty engines purchased from America, namely thirty from the Baldwin Locomotive Works at Philadelphia, and ten from the Schenectady Works, are now working on the line, and so far they are doing their work in a satisfactory manner and taking the same loads as the engines built in this country. They are, however, heavier in the consumption of coal and oil than our own engines doing the same work."

On the other hand, a Midland driver (or foreman) writes in distinctly uncomplimentary terms about the American engines imported by that railway. He says: "It is evident the Midland locomotives from America are not worthy to be classed among the 'best' in that country, or their qualities of excellence would appear in this. As it is, the above engines are many years behind the times. One great fault lies in the bar-framing, which takes a good foot from the width of the fire-box, and, although a greater length is given, it doesn't counterbalance the evil. The lower tubes soon get choked with ashes in the smoke-box, while those at the top are too high to be acted on properly by the blast-pipe. Although they burn more coal than a 'Midland' engine, owing probably to the construction of the fire-box, as well as to the blast-pipe and tubes, in the sense above referred to, they are indifferent generators of steam. They require more oil than a Midland engine, and the 'needle' system of regulating it to the journals is vastly inferior to the old worsted trimmings, being, in fact, unsatisfactory from every point of view. A comparatively slight 'bump' against a Midland-built engine, whilst it produces no damage to the latter, doubles up the framing of the American—a case in point coming under my own observation only a fortnight ago. A driver is allowed 35 minutes to get a Midland-built engine ready for work—none too much—30 to put her away. It will take him—I speak as well of the

fireman—an hour to get the American ready, and fully 50 minutes to put her away at the end of his journey, and they have to work harder, too, to do it in the time. Altogether, they are veritable brutes, and a fireman, not to mention the driver, deserves at least a 50 per-cent. rise in wages." I quote these remarks without any comment, beyond the observation that my own experiences with American engines on other British railways were very different.

For, if the importation of American locomotives be a novelty in the Mother Country—barring the sporadic experiment of half-a-century or so ago—it is nothing new so far as most British colonies are concerned. I have had the advantage of personally studying the work of American engines in several of those colonies, but for my present purpose it will suffice to take the case of the one with which I have been most intimately connected, New Zealand, the most staunchly British of them all.

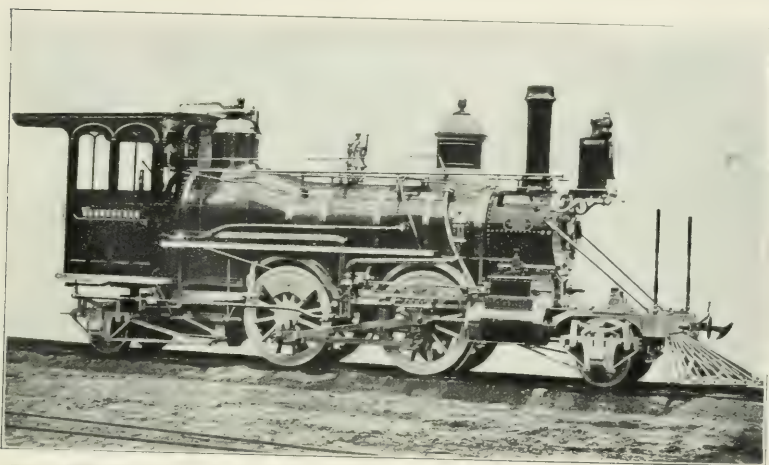
Early in the inception of New Zealand's State-Railway system it was found that none of the British types already in use fulfilled all the requirements of a main-line traffic on a track of 3 foot 6 inches gauge, mostly laid with iron rails weighing only 40 pounds to the yard. The most efficient types had been an English "Mogul" class ("J"); a six-wheel coupled class of saddle-tank engines ("F"); and Fairlie engines of the single-boiler type (class "R"). But it was desired to run expresses at an average speed of 30 to 35 miles an hour and to haul heavy freight of "mixed" trains up long 2 per-cent. grades with reverse curves of 500-foot radius. At that time two of my intimate friends, Mr. William Conyers and Mr. Allison Smith, were chief commissioner and locomotive superintendent respectively. I believe that both agreed in the advisableness of sending to America for engines of the type required. At any rate this was done so far back as the "seventies." The express passenger-engines were the first to arrive. They were locomotives strictly of the American type in all respects, save that instead of having a four-wheeled bogie at the leading end they had two two-wheeled Bissell bogies, or pony trucks, one leading and the other at the trailing end. I have never been able to discover that any advantage was gained by the departure from the normal American type, but it was persisted in even when six-coupled wheels were employed instead of four, as the loads became heavier—indeed, up to 1893, when the standard American "ten-wheeler" type with four-wheeled leading bogie was substituted. The earlier locomotives, Class "K," had cylinders 12 by 20 inches and 4-foot coupled wheels. They were eight in number and were supplied by the Rogers

Company of Paterson, New Jersey. The heavier engines which came out about the year 1880 were of the regular American "consolidation" class, with cylinders 15 by 18 inches, eight-coupled wheels, 3 feet in diameter, and a leading Bissell truck. They were built at the Baldwin Works, Philadelphia, and numbered six. Their class letter is "T."

Now these fourteen engines have been in regular work on the New Zealand State lines for more than twenty years, and I do not think that any capable and unprejudiced authority in the colony will contradict me when I say that they have proved from the first most efficient and satisfactory machines. The "K" class engines ran the Christchurch-Dunedin expresses for several years with entire satisfaction to everybody. The trains were not usually heavy, consisting ordinarily of six to eight long American bogie coaches—these being imported from the United States as well as the engines—nor was the timing fast, being at an average speed of about 30 miles an hour between stations, while a maximum of 36 was not supposed to be exceeded, though, as a matter of fact, speeds of 40 to 45 miles an hour were not uncommon when time lost by delays had to be made up, and I have several times personally recorded speeds of 48, 50, and 53 miles an hour with these engines. Once I noted a rate of 55 for a short distance, and even then the engine was not at all pressed. I do not doubt that 60 could have been reached had this been desirable. Also, the ascent by these engines of the long 2 per-cent. grades with sharp curves was very creditable, considering their small tractive force, only 60 pounds for every pound of effective pressure in the cylinders, and their low steam pressure, only 130 pounds per square inch. Thus the work done was distinctly good all round.

Nor were the "T" class "consolidation" engines at all behindhand in their different sphere. It was soon found that whereas the English "F" class with cylinders 10½ by 18 inches and 3-foot wheels six-coupled, could take only 13 loaded waggons up the 2 per-cent. banks, and the "R" class single-boiler Fairlies—which had cylinders 12¼ by 16 inches, and six-coupled wheels 3 feet in diameter—only 18, the American "consolidation" engines took 27 with certainty and comparative ease. This is not recorded as a triumph of American over English locomotives, for the great superiority of nominal power necessarily went a long way in accounting for the difference in work, but simply as noting the fact that the American engines proved a success and that their importation was justified by the result.

But in a few years the traffic had outgrown the capacity, not only of these engines, but of the railways themselves as well. The cheap-



EARLIEST AMERICAN EXPRESS ENGINE IMPORTED FOR NEW ZEALAND RAILWAYS.

Built at Rogers Locomotive Works, Paterson, N. J. Gauge 42 inches, cylinders 12 by 20 inches, coupled wheels 48 inches diameter. Class K.

ness and slightness of the original construction of the roads soon proved a costly error, and as rapidly as possible the 40-pound iron rails were replaced all along the main lines with 53-pound steel rails. The "K" engines frequently had to run double on the expresses, and sometimes even one of the "consolidation" engines was put to this very unsuitable duty, which nevertheless it always fulfilled very well; but the plan of running an eight-coupled freight engine with 3-foot wheels at fairly fast speeds down falling grades was not to be com-

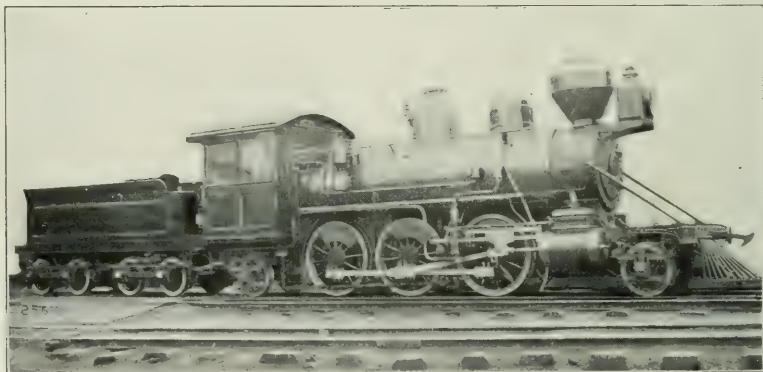


NEW ZEALAND RAILWAYS CONSOLIDATION LOCOMOTIVE.

Type of 1879. Cylinders 15 by 18 inches. Built at Baldwin Works.

mended. So designs were got out for twenty new engines, ten of which were virtually a great enlargement of the "K" type, with a third pair of 49-inch coupled wheels, placed between the other two pairs. The cylinder diameter was increased to 15 inches, and larger boilers with augmented steam pressure were provided. The leading and trail-

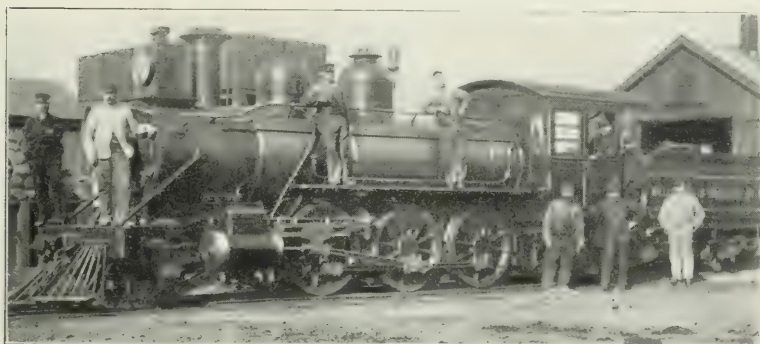
ing Bissell bogies were retained. The other ten engines were to be enlargements of the "T" or "consolidation" type, with cylinders 15 by 20 inches and 41-inch wheels six-coupled. By this time British patriotism had revolted against the idea of importing from America what could be made in Britain, so the order was sent to a leading British firm. The results were (1) that the Colony had to wait two years for full delivery of the locomotives; (2) that the first two delivered were found to be of excessive weight; (3) that protracted correspondence and negotiation and disputation took place, the outcome being, if I am correctly informed, that a mutuality of mistake was shown, and all twenty engines had to be altered in various ways to enable them to run over the New Zealand bridges. This, of course, meant terrible delay, and the need of more powerful engines had become urgent.



NEW ZEALAND RAILWAYS SIX-COUPLED LOCOMOTIVE, WITH FRONT AND REAR PONY TRUCKS. CYLINDERS 15 BY 20 INCHES.

So once more recourse was had to America, and, as before, with a wholly favourable result. Twelve engines were ordered by cable message—six of each class. They were supplied by Messrs. Burnham, Williams & Co., of the Baldwin Works, Philadelphia, and were delivered in New Zealand within five months of the date of the order being despatched, also at a cost of about £400 per engine less than that of those English-built. Moreover, so soon as they arrived they were put to their work and did it excellently. These were classed respectively "N" and "O." I should mention that the American "O" class have 36-inch wheels and 18-inch piston stroke, not 41-inch and 20-inch respectively, like those ordered from Britain.

The class "N" engines have been employed for fourteen years, mostly in working the Christchurch-Dunedin expresses between the former city and Oamaru, a distance of 153 miles, and are the only



EXPRESS ENGINE BUILT FOR WELLINGTON & MANAWATU RAILWAY, NEW ZEALAND,
BY THE BALDWIN WORKS.

This locomotive made the record run for 42-inch gauge—64.2 miles an hour, in 1892. It has cylinders 15 by 20 inches and six-coupled wheels 49 inches in diameter. Class N.

engines either given a schedule speed of 30 miles an hour or authorised to attain a maximum of 36, since their smaller predecessors of class "K" were relegated to inferior duty. Testing them twice for speed, I obtained rates of 58.5 and 59.2 miles an hour respectively, for short distances down falling gradients with loads of about 100 tons behind the tender. It must be remembered that this was on a 42-inch gauge and with 49-inch wheels six-coupled. At that time the speed was, I believe, an unquestionable "record" in such circumstances. Their haulage power also was very noteworthy. On one occasion under my own observation, when an engine of this type was "working back" in the ordinary course, it took without the least difficulty no fewer than 81 waggons loaded with wheat, a very solid class of freight, and with



STANDARD EXPRESS ENGINE, NEW ZEALAND STATE RAILWAYS. BUILT AT THE
BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

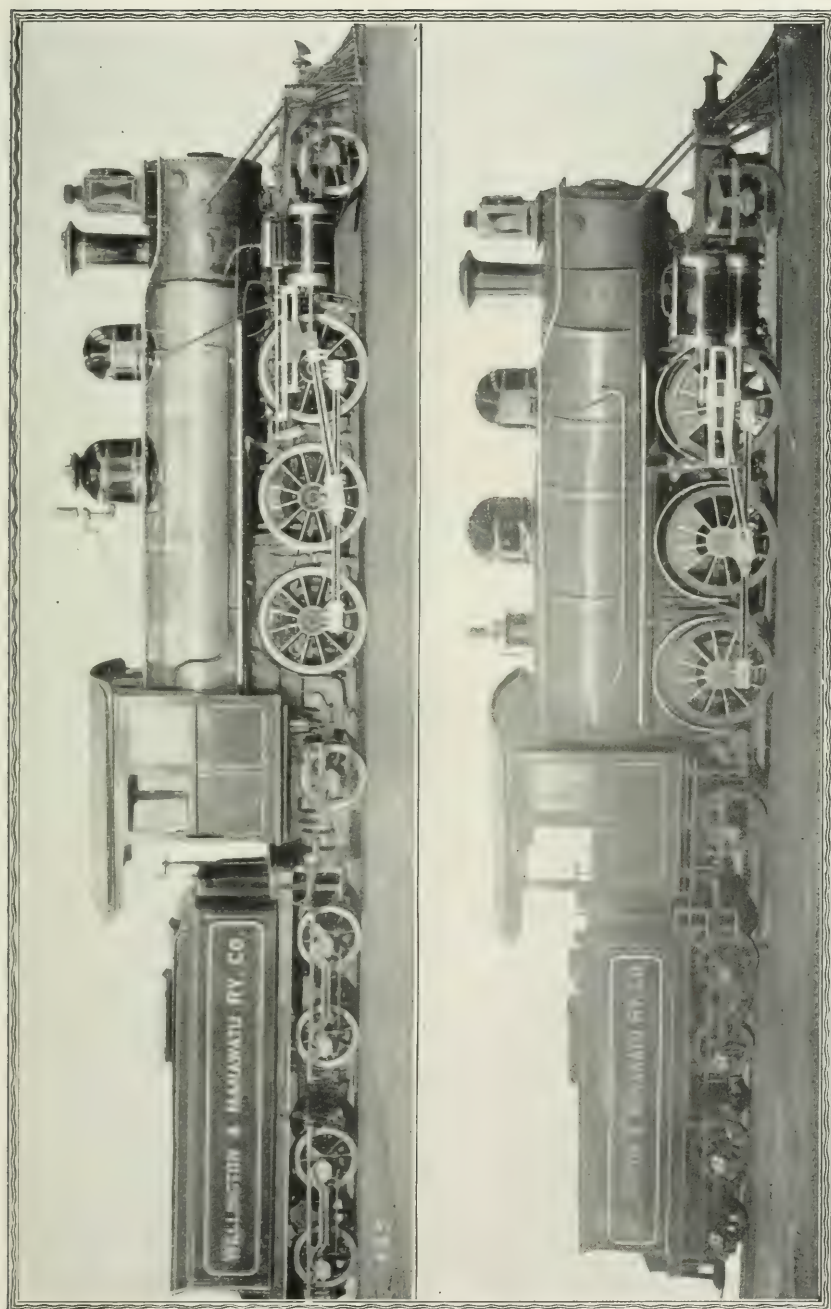
42-inch gauge, 49-inch coupled wheels; cylinders 15 by 20 inches. Class N.

this load ran at 25 miles an hour on the level. The "consolidation" locomotives of the "O" class proved even more useful than class "T."

About nine years ago the Wellington and Manawatu Railway Company, which, although a privately-owned line, covers the first 84 miles from Wellington, the Capital, of the (still unfinished) Main Trunk Railway through the North Island of New Zealand—intended ultimately to extend from Wellington to Auckland—and which up to that date had used only British locomotives, requiring some more, took warning from the experience of the New Zealand State Railways and sent the order direct to the Baldwin Works, Philadelphia. The engines ordered were of two classes; one was an improved edition of the class "N"; the other engines were of the "consolidation" order, but had 42-inch eight-coupled wheels and cylinders $16\frac{1}{2}$ by 20 inches. Both have done splendid work. One of the large "consolidation" class took a load of eighteen American bogie cars on the level at 36 miles an hour, and one of the six-coupled "N" class broke all past records of the 42-inch gauge and established a new one by taking a light special train from Wellington to Longburn in 2 hours 2 minutes traveling time, and ran from Otaki to Longburn, a distance of 37.2 miles on easy grades, in 46 minutes 4 seconds, with an intermediate slack for relays and another over a bridge, or at an average speed of 48.5 miles an hour start to stop. If the delay through the two slacks be taken into account the start-to-stop speed was just 50.8 miles an hour. For sixteen consecutive miles a speed of 60 miles an hour or upward was maintained and a maximum of 64.2 was reached during a single mile, the engine running with entire ease and smoothness. I travelled on the footplate and made minute observations throughout the entire journey.

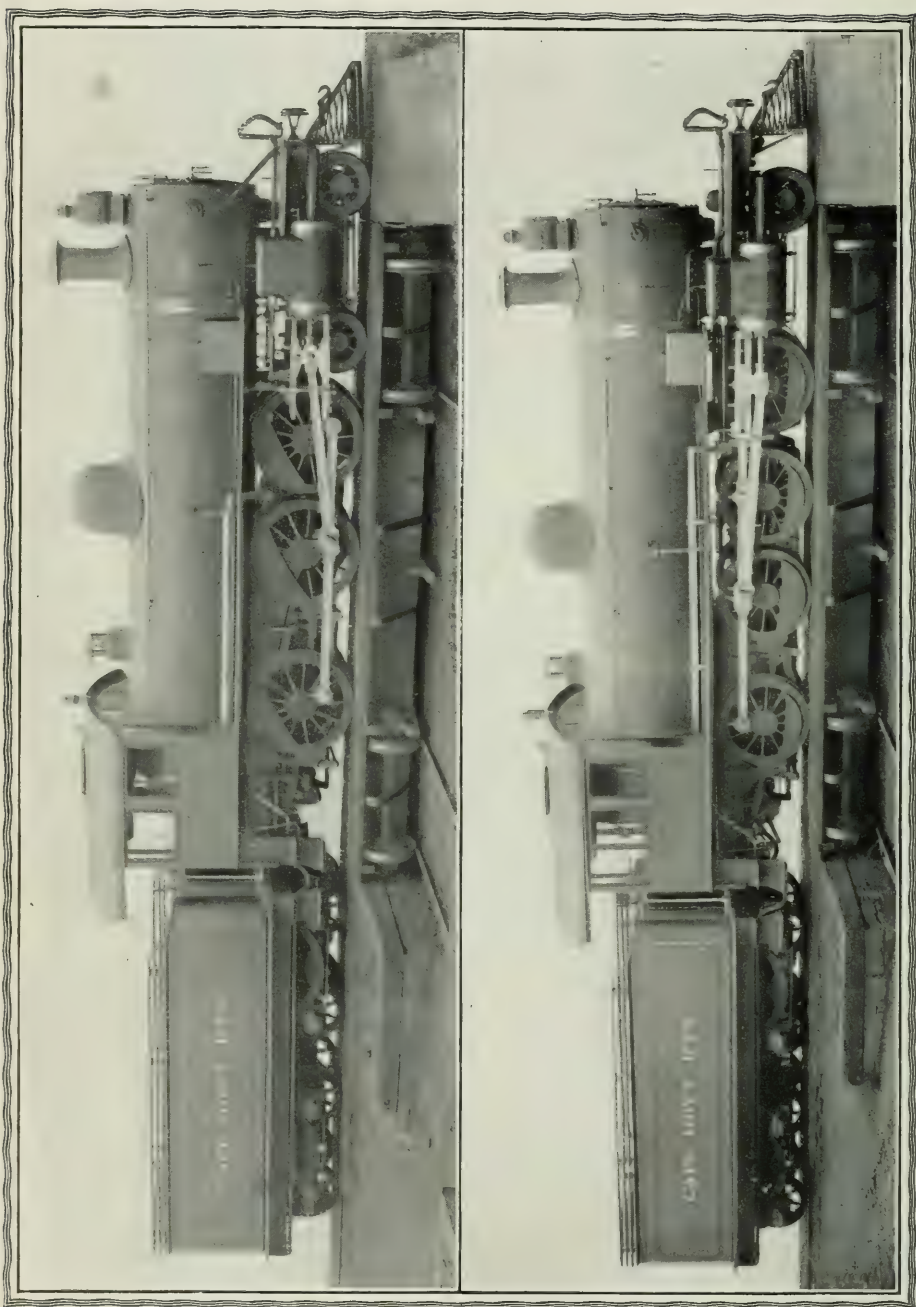
More recently the same railway company has imported several Vaucrain compounds, built by the Baldwin company, and I hear good accounts of them. But the point is that since that railway first tried the experiment of procuring locomotives from America, none have been obtained elsewhere by the directors of that company. The fact is in itself suggestive.

Similarly on the State Railway of the colony, when more engines were needed recently, as the New Zealand workshops, which had turned out a number of most creditable and useful locomotives, proved unable to keep up a sufficient supply, America was again resorted to. It is true that under the influence of the patriotic wave which swept over the British Empire in 1897 in relation to the Queen's "Diamond Jubilee," an attempt was first made to obtain some engines in Britain.



ENGINES FOR THE WELLINGTON & MANAWATU RAILWAY, NEW ZEALAND. BUILT AT THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA, PA., U. S. A.

The upper picture shows the six-coupled engine with pony truck front and rear, first run in 1891; the lower is the compound six-coupled with pony truck first run in 1894. Diameter of high-pressure cylinder, 10 inches; of low-pressure, 17 inches. Stroke, 20 inches.



NARROW-GAUGE LOCOMOTIVES BUILT FOR THE CAPE GOVERNMENT RAILWAYS, SOUTH AFRICA BY THE SCHENECTADY LOCOMOTIVE WORKS, SCHENECTADY, N. Y., U. S. A.

Both are 42-inch gauge; the 10-wheel engine above has 54-inch drivers, 11 feet 4 inches rigid wheel base, $17\frac{1}{2}$ by 46 inch cylinders, weighs 107,830 lb., of which 85,350 lb. is on the drivers, and carries 180 lb. steam pressure. The consolidation freight locomotive below has 48-inch drivers, 14½ feet rigid wheel base, $18\frac{1}{2}$ by 24 inch cylinders, weighs 115,450 lb., of which 101,670 lb. is on the drivers, and carries 180 lb. steam pressure. Built in 1900.

But the experience proved an exact counterpart of that which brought about the orders given by the three British railway companies last year. All the manufacturers were so full of orders that they could hold out no hope of a reasonably early delivery, with the single exception of Messrs. Sharp, Steward & Co., who undertook to supply a few. So again New Zealand went to America and ordered from Messrs. Burnham, Williams & Co. (1) ten express engines of the American "ten-wheeler" type; (2) twelve ten-wheeled tank-engines with leading and trailing Bissell trucks. Thus the total number of American engines at work on the New Zealand railways up to the latest date of my advices was fifty-two, and I believe I am warranted in saying that the experience of their performance in regular practice has been almost uniformly favourable. In my own association with them I found that many British drivers who at first despised and disparaged the American engines as mere "Yankee notions" soon grew to appreciate their efficiency and hardiness, while some higher officials—one of whom characterised the first American locomotive imported as "a braying abortion," came to learn that it was possible for a good engine to be built outside Britain, a lesson not easily inculcated or assimilated when a genuine John Bull is the pupil.

I had written so far when I received a reply from Mr. Allison Smith to my enquiry as to his personal experience with American locomotives on British colonial railways, notably those of New Zealand and Victoria, while he held office as chief mechanical engineer in each case. "My own experiences," said Mr. Allison Smith, "were entirely satisfactory. The sole drawback originally attaching to American engines was that their bogie and tender wheels were made of chilled cast iron. These, of course, could be easily replaced in America when necessary, but not so in the colonies. Therefore we substituted for them ordinary waggon wheels, which we put on the same axles. But otherwise the American locomotives gave us complete satisfaction. It is true that at the outset an attempt was made in Australia by certain persons, no doubt in the interests of local manufacturers, to get the American engines condemned as inefficient, but I found that the locomotives had been tampered with, or at least had undergone undesirable alterations which impaired their steaming power. Directly I rectified these things they steamed splendidly and did their work to admiration. Indeed, so much better are American engines suited than British engines to colonial railways, with their rough and lighter roads, that in my opinion no others ought to be used on those lines."

I cannot do better than to leave the matter at so satisfactory a point.

ENGINEERING OPPORTUNITIES IN CENTRAL AND SOUTHWESTERN ASIA.

By Alexander Hume Ford.

Mr. Ford's preceding article, in our February issue, dealt with Russia's schemes for internal development by the perfection of means of transport and communication, already largely crystallized into definite systems. In the present paper he advances to the farther-outlying portions of the Tzar's growing empire—to regions teeming with new influx of life, seething with new activity, clamorous with demand for the means and the machinery wherewith to work up their rich resources, but so many-voiced that their needs can hardly yet be classified and orderly arranged. And in this harvest of opportunity, too vast for any one band of workers to gather, he urges the great industrial nations to work in harmony and co-operation.—THE EDITORS.



WITH Russia pushing the industrial development of her Black Sea and Central Asian districts so vigorously that she cannot begin to supply the number of engineers or the material needs for the carrying out of her stupendous projects, it is lamentable that the exporting manufacturers of the

great Anglo-Saxon nations should maintain separate and antagonistic trade organizations and combinations in this part of the world, seeking to interfere with each other, instead of realizing that their interests are identical and demand hearty co-operation.

In parts of European Russia there is an annual increase of 30 per cent. in the number of factories and machine shops erected, some of them equipped with the most modern and powerful machinery in the world; in Trans-Caucasus, the hand loom is being replaced by the cotton mill, worked by steam or water power; the three thousand miles of the Trans-Caspian Railway, although built solely as a military road, have been of necessity turned over to the Department of Commerce, owing to the unexpected and enormous increase in traffic along the line; not merely this, but so rapid has been the unlooked-for development and settlement of central Asia by European Russians that it is now deemed necessary that three additional railways should be built to connect the Trans-Caspian system with that of European Russia. One of the projected roads is to descend from Orenburg in the Urals,

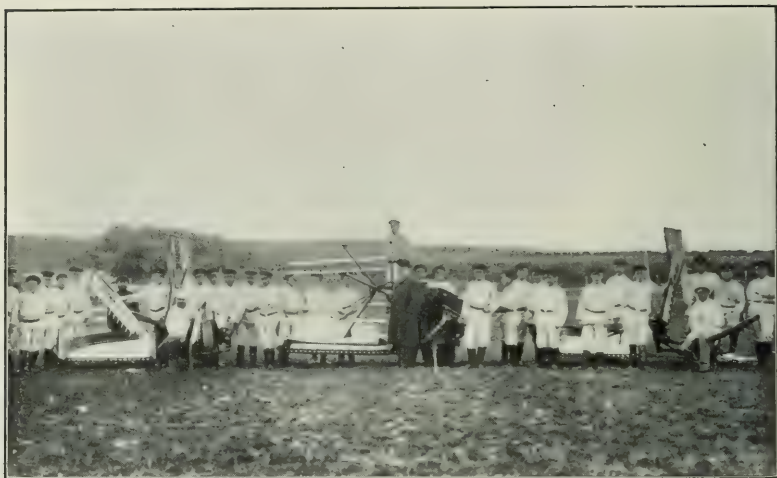
another from a point not far distant from Astrakan, while the third (and the most important to America), is being constructed across the Caucasus Mountains, with the aid of capital secured in Wall Street, and in time will be continued on to Teheran.



A PRIMITIVE HOME OF NOMADIC TRIBESMEN IN CENTRAL ASIA

The building of this railroad is certainly the most difficult piece of engineering yet undertaken by Russian engineers, although possibly men who surveyed and built the Canadian Pacific and other railroads through the Rocky Mountains might look leniently upon the engineering difficulties encountered between Vladikavkas in the clouds and Petrovsk on the shores of the Caspian Sea, and thence to Baku. This road has just been all but completed, and now connects all Russia with the ferry across the Caspian plying between Baku, its present terminus, and Krasnovosk, the starting point of the Trans-Caspian Railway. The Petrovsk road passes through many gorges where swollen mountain streams sweep down, carrying away bridges and wrecking miles of track, and as the railroad is the only connecting link between the cotton mills of Moscow and the plantations of Central Asia, which supply the raw material, the importance of uninterrupted communication cannot be overestimated.

With the completion of this through rail and steamship line from Russia's capital to western China and to Herat in Afghanistan, the peopling of central Asia with Little Russians is progressing with renewed energy, and Russia is brought within hailing distance of her long-coveted port on the Persian Gulf, insuring the carrying out of the stupendous engineering projects outlined for the advancement of the Tzar's Empire to convert central Asia into a granary and store-



A CLASS IN MODERN AGRICULTURAL METHODS AND THE USE OF MACHINERY.

house of supplies. Already an American syndicate, at the invitation of the Tzar, has sent over its engineers and experts to report upon the possibilities of converting a vast desert into a well irrigated and richly producing area. If the report is favorable, the syndicate is to invest \$70,000,000 in the construction of canals and irrigation works, in return for which it receives rent free for many years a large tract of land, besides many other valuable concessions.

Until Central Asia is adequately opened up by the completion of the proposed Persian Gulf railroad, all foreign equipment for her growing industries must enter the Russian Empire through Black Sea ports. In fact, trade impetus has long been felt in this region. Great caravans no longer cross the Pamirs from India. Tea and other products are sent from Bombay by steamer to Batum, and thence overland by rail and boat to central Asia, benefiting both the railroad revenues of Russia and the shipping interests of Great Britain.

So important is the Black Sea as a commercial highway that some time ago an American line of steamships was put on between New York and Odessa; but notwithstanding the fact that the freight was carried in British bottoms, a fight was made on the new line, and as the war with Africa sent charter rates ever upward, for a time shippers of machinery and rails were compelled to ship via Liverpool and Hamburg, as before. But Russia seems determined to have an American line, and the recent ukase forbidding any foreign vessel to stop at more than one Russian port will help rather than hinder American possibilities in the Black Sea.

It is from this district that the energetic business-seeking Hebrews of Russian birth have come to New York. Some have become American citizens, others have remained Russian subjects; and as 51 per cent. of the stock of all Russian steamship companies, as well as that of certain other industrial concerns, must be owned by Russians, the aid of the Russo-American has already proved invaluable to the business interests of the United States.

As the building of the Trans-Siberian Railway has compelled the present construction in America of the largest freight-carrying steamships in the world, besides giving an impetus to American industries and investment in northern Asia not dreamed of a decade ago, so history is repeating itself in the south-western part of the continent. In Manchuria and Siberia, American and English machinery drove out all competition in short order, and should the interests of these two nations consolidate in the near East, the same result would inevitably follow there. Already Belgian structural metal is giving way to American. Germany imports machinery from the United States to Hamburg and exports it again to the Black Sea ports as her own.

German manufacturers and investors, realizing that they place themselves at a manifest disadvantage in attempting to compete with the industrial output of both Anglo-Saxon countries on an equal footing, while not giving up the fight in Russia, have turned to Turkey, buying up her railway system, so that none but German material will



THE "NEW ERA" MACHINE GRADING THE LINE OF THE SIBERIAN RAILWAY.

hereafter be used in building extensions, and only German goods will be carried over the lines at fair rates.

In fact, everything demonstrates that in the near East is needed a vigorous application of the Anglo-American open-door policy. At present Russia would doubtless lend her aid in forcing the issue, for Germany has ruthlessly entered like a wedge between French and Russian interests in Asia Minor, forcing Russia back upon the Black Sea coast, along which she has projected her railroad in Turkey, while from Trebizond southward a main line will run down through Armenia and Persia. It is at Trebizond that American ships will probably be called upon to land their cargoes of rails, locomotives, and track-laying tools needed for these new Russo-Asiatic railroads.

England's sphere lies still further south, beyond that of France. Awakening at last to her imminent danger of being entirely shut out of southwestern Asia, the project of a British railway from the Holy Land to Bagdad, possibly continuing on to India, has been revived; so that there now seems a possibility of the Cairo-Calcutta Railroad be-



MECHANICAL EXCAVATOR WORKING ON RUSSIA'S CENTRAL ASIAN WATERWAYS.

ing built. It is even suggested by the United States consul at Constantinople that American capitalists should construct a railroad southward from one of the Black Sea ports, through the richest agricultural districts of Turkey, which are also the center of American missionary effort.

Certain it is that the near East is being awakened from her long slumber. On the Black Sea new ports are being constructed, harbors deepened, and many improvements made in which Anglo-American machinery and engineering plays no small part. More than ever Rus-



LAUNCHING THE ICE BREAKER AND TRAIN FERRY ON LAKE-BAIKAL.

The boat is built after the model of the car-ferries on the American Great Lakes.

sia feels the need of her projected Black-Caspian Sea ship canal, which would make Krasnovodsk an important seaport. In fact, with the harbors of the Caspian being deepened with British-built American dredges, the most complete and largest in the world, it is not surprising that Anglo-American capital seeks investment in the oil wells and other industries about the shores of this great inland ocean, which is rapidly becoming more and more familiar to our western engineering experts.

Now that the great beyond, central Asia, once the teeming center of earth's greatest multitudes, is at last opened to the inspection of the world and outside aid courted to make it again the center of the world's commerce and industries, the Anglo-Saxon will not be slow to enter.

More than ten million peaceful workers now inhabit this region. Along the line of railroad Russian cities of 30,000 inhabitants have sprung up, while trains leave Krasnovodsk daily, laden with emi-



A HAND LOOM IN THE CAUCASUS.

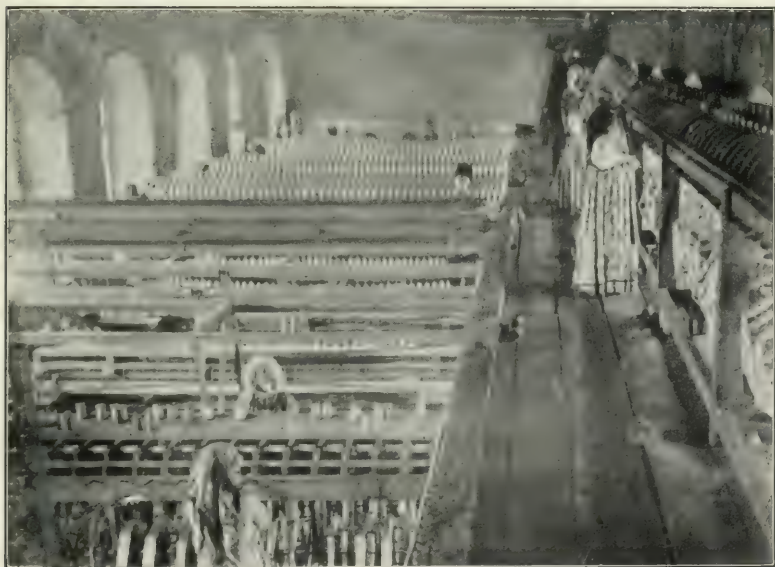
The type of appliance which is giving way to modern mechanical apparatus.

grants, machinery, and mixed freight. Everywhere along the line of road are encountered mechanical problems which can be successfully solved by the brain of the inventive engineer alone. At Krasnovodsk the fresh-water supply is distilled from the Caspian. Tanks carry it for hundreds of miles inland to Kazil Arvit, where the repair shops of the railway are located. The immense steam hammers and excellent tools of these extensive shops were supplied by German factories a dozen years ago, yet the plant is still capable of turning out complete modern locomotives. The government, however, finds it more economical to import from America.

The country about abounds in iron, copper, and sulphur mines; oil is also found, the refuse of which is used as fuel. With the new life throbbing through the country, smelters, forges, and many new kinds of machinery will be needed, much of which must necessarily be of a type which Russia cannot hope to manufacture at present. In fact, it will be many years yet before Russia can begin to supply her own needs in central Asia. Small factories are springing up everywhere beyond the Caspian, so that hand labor is decreasing, while new demands for mechanical appliances occur continually. Farmers and merchants combine to purchase machinery on the co-operative plan; private individuals spend large sums establishing new industries, and are invariably rewarded by the government. Trees, cotton plants, grape vines, and many kinds of seeds are imported. Cotton culture, for instance, has grown from the insignificant beginning of a few

years ago to such proportions that Russia now considers herself independent of Egypt and America. Primitive cotton presses must soon give way to the powerful steam moguls used in the southern States. Bagging factories must make their appearance, and to compete on an equal footing with other nations for the cotton-goods market of Asia, doubtless the experiment of building great cotton factories in central Asia will be tried. The time-worn Russian policy of admitting duty free such mechanical appliances as her people may need to develop infant industries is already resorted to, but whatever industries are started are nevertheless assured ample tariff protection.

Owing to the fact that until very recently all central Asia has been under absolute military control, no one being allowed to travel on the Trans-Caspian Railway without a permit from the war department, foreigners have had little or no opportunity to investigate its possibilities for investment. That there are opportunities for Anglo-American enterprise there now remains no doubt. It is still impossible, during wind storms at night, for the trains to run over certain portions of the road, as the sand of the desert is piled up in billows across the tracks. So far, Russian engineers have found no means of successfully combatting the sand. Again, in the building of dams for irrigation, they have left much to be desired, and the perfection of the canal system of central Asia is the paramount necessity of the country.

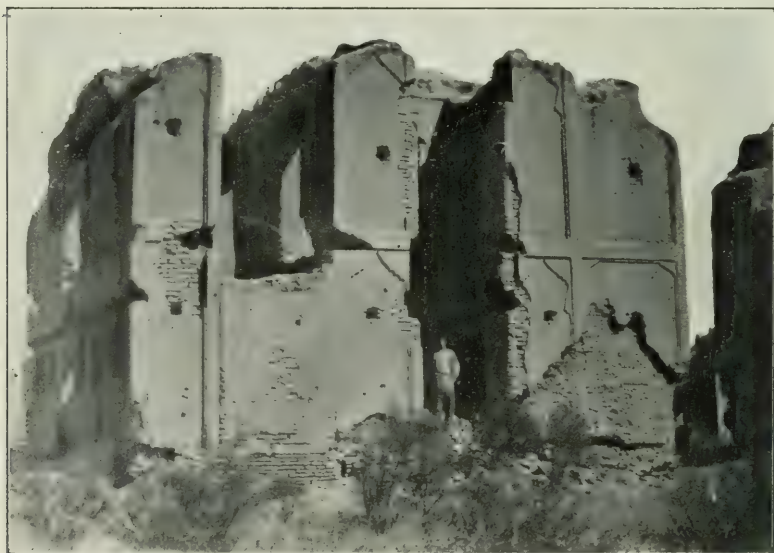


A BEGINNING IN THE USE OF POWER IN THE SILK INDUSTRY.

Merv, a city miles in extent, now destitute of a living soul, was ruined in a night by having its aqueduct cut by the enemy. The Murghab, however, is again being deflected into its ancient lateral waterways, immediately demonstrating the truth of the boast of the ancients that there is no spot in the world more productive than this oasis.

The Russian Government has very wisely left the matter of contracting for irrigation works in the hands of the various tribes and communes. The headsmen make their contracts for engineering works, then put the entire colony at work, dredging ditches and carrying out the orders of the engineer. Primitive methods are giving way to the improved systems introduced into India and America by the Anglo-Saxon.

Under irrigation, former desert lands yield 26 tons of grapes to the acre, and so superior are they that thousands of tons are annually transported by rail into Russia. Irrigation is redeeming vast areas, and it alone makes necessary the building of the various lines projected across the desert between European Russia and Turkestan, which latter country is already well settled with Russian peasants assisted by the government. At the base of the Afghan mountains the supply of water is plentiful. Rivers as great in volume as the Missouri flow down from the hills; steamboats ply the streams along



A RUINED FORT AT MERV, TURKESTAN.



SUMMER HOME OF NOMAD TARTARS NEAR EKATERINENBURG, URAL MOUNTAINS.

The booth is made of skins stretched over a wooden framework. Inside of this house was found—a Singer sewing machine. Photo by E. O. Hovey, Esq.

the Afghan border, carrying Russian tradesmen and commerce toward India. In fact, the great crying need of central Asia is a shipyard on the banks of the Amu Daria for constructing river steamers. So great is the volume of this river and the amount of deposit carried down that the level of the Aral sea is rapidly rising, so that its waters may yet in time overflow its banks, seeking an outlet in the bed of the ancient gulf connecting the Aral Sea with the Caspian; or the engineers may decide to construct a canal between the two seas, instead of turning the course of the Amu Daria at Tcharjin, as it is now proposed to do. If either of these projects is ever accomplished, and steamers can ply from the Volga to the edge of India, the economical balance of Europe will be overturned. At present, owing to the enormous cost of trans-shipment of goods on both sides of the Caspian, it is still possible during certain seasons, in spite of a seemingly prohibitive tariff, for American cotton to compete with the central Asian product. Should the canalways and rivers of Europe be made tributary to this new cotton-growing region, Russia could undersell American cotton in the markets of Europe as frequently as she does American wheat in the Trans-Atlantic grain exchanges, to say nothing of tobacco and other products of American seed she is introducing in her new Asiatic garden, which may spread over a million square miles in area, destined soon to be intersected by many rail and waterways.

However, many years must pass before Russia can hope to compete in manufactured articles, machinery, etc., with the older nations, and in the meantime it should indeed be a golden age of profit to those best able to supply the material for the development of every kind Russia is bringing about over an area of 8,000,000 square miles, affecting over 130,000,000 people, whose wants are increasing year by year as an autocratic government forces education upon them; for Russia is at last most certainly making a real and earnest endeavor to uplift her illiterate masses.

The throwing open to the world of the Trans-Caspian road is but a forewarning that a general breaking down of barriers is to take place. Russia seems about to emerge from her semi-seclusiveness, to take her place among the industrial nations of the world. As a sign of the times, she has repeatedly invited England to meet her half way in the extension of railways into Afghanistan. Russia is quite willing to undertake the "pacification" of the Ameer and to overcome his objections. It is true that the advantages accruing to Russia, should she ever secure through rail connection with India, would be of inestimable value; but that it is eventually inevitable that the connection will be made seems most certain to impartial observers. The consensus of opinion, even in England, is that it would be well for Great Britain to make the best terms possible with Russia while she may; for under certain enforced treaty regulations, a through line from Calais to Calcutta might be made of equal commercial importance to both England and Russia. When it is taken into consideration that mail sent from London to Shanghai via the Trans-Siberian Railway, even before that road is completed, reaches its destination far in advance of matter sent by water, the possibilities of rapid train service carrying important dispatches through to India in seven days is readily seen. With the completion of but four hundred miles of railroad through the valleys of Afghanistan, perishable freight could be forwarded from Great Britain to her oriental colony, and *vice versa*. Business men could make the trip between the two countries within the week. India and England would be drawn many days nearer each other. Russia's advantages would certainly be great, it is true, and to secure them she would be willing to grant many concessions. It is very probable that in exchange for permission to make the desired rail connection with the Indian system, Russia would lift from English through goods the embargo of extortionate rates now exacted on all foreign merchandise going into or through central Asia. It is too much to expect that the request for an open door in central Asia would receive any favorable



DEMIDOFF IRON MINES, TAGUI, URAL MOUNTAINS.
Showing the method of taking out the ore (magnetite) by benches.
Photo by E. O. Hovey, Esq.



TARTAR MINERS IN THE GOLD PLACER MINES AT MIASK, URALS.
By courtesy of E. O. Hovey, Esq.

response, but although Russia is already pushing her railways through Persia to the gulf, it is not too late to save that country almost intact for the now world-announced Anglo-American policy.

In northern Persia, Russian sway is absolute. Splendid roads, built by the Tzar's order, abound; bicycling there and in central Asia is a common sport. Russia's wand of progress is touching the land; misery, poverty, and slavery pass away, to make way for enterprise and prosperity. The credit of this can no longer be held back from Russia. Wherever her iron rails have gone, cities regularly laid out have sprung up, perfect sanitation and fine buildings are the rule,



ON THE LINE OF THE SIBERIAN RAILWAY. AN AMERICAN-BUILT BRIDGE.

Photo by Prof. S. W. Beyer.

sturdy settlers bring new life into the country, and all is activity. Restless energy is to-day at work everywhere in central Asia; all that is lacking is perfect means of communication with, and transportation to and from, the outer world.

It would seem that no nation has a right to demand in Asia an open-door policy, and at the same time seek to throttle the very life of its most energetic child. Under the new conditions beginning to exist, the Slav must find his way to the Indian Ocean. By the natural order of things, Russia must soon break through. Her surplus population increasing at the rate of two million annually must find new homes in less crowded portions of the Empire. One hundred and thirty million people press down upon southwestern Asia, and the strain is continu-



A TARTAR VILLAGE OF MINERS, WONLIARLIARSKY COMPANY'S MINES, NEAR
TSCHELIABINSK, SIBERIA.

By courtesy of E. O. Hovey, Esq.

ous as the overflow is eternal. Once Russian rails are laid to the two Persian Gulf ports the Tzar has acquired from the Shah, now little more than his vassal, great cities and vast enterprises must inevitably spring up. Bombay and Calcutta will have rivals, it is true, but rivals that will increase their trade; for through these gateways of commerce for years to come must pour the material needed for the exploitation of the new Empire. Until from these prospective gulf cities Russia can dispatch her merchant marine fleets to all parts of the world, England and America will not only be called upon to build more war-ships and merchant vessels for the Muscovite, but with Persian ports almost in the track of British oriental trade, and half-way between the Atlantic and Pacific ports of the United States, all Anglo-Saxondom must inevitably share in the prosperity and development of central and southwestern Asia. Germany alone is capable of proving a rival; and as America is now becoming a nation with a vast surplus of wealth seeking profitable investment abroad, it would seem well for England and America to work hand-in-hand with Russia for the development of the Asiatic domain of the Tzar, but at the same time to insist on an open-door policy for all time in any new territory they acquiesce in permitting Russia to dominate, thus assuring the manufacturers, inventors, and engineers of future generations the possibility of room for the vigorous expansion of their genius and ability.



COST DETERMINATION IN ISOLATED ELECTRIC PLANTS.

By Percival Robert Moses.

In every department of mechanical production, the foundation of safety and success is an accurate knowledge of costs. Mr. Moses considers this study in a comparatively new field—the small but varied individual power plant—from which valuable lessons of wide importance may be learned.—THE EDITORS.

A NUMBER of interesting articles have appeared from time to time in THE ENGINEERING MAGAZINE on the subject of cost keeping and cost finding in manufacturing plants, and the vital necessity of such systems has been universally recognized. The lack of a similar system in the operation of individual electric plants in buildings is a serious drawback when the question of designing new plants or improving old ones is laid before an engineer or architect; and it accounts in great measure for the small improvement to be seen in the apparatus and methods employed in these plants.

The question may be: "Shall we use hydraulic or electric elevators?" or, "Is electricity cheaper from a central station at so-and-so much per kilowatt hour, than it would be from our own plant?" or, "What will it cost to use water-tube in place of horizontal-tubular boilers?" Each consulting engineer has, presumably, collected more or less accurate data on various questions, which enable him to design the plants he installs; but the owner who pays the cost of running, seldom knows, after the plant is installed, the cost of separate items. Frequently a change in methods or apparatus is proposed, and he finds that he has no means of settling the question of its advisability. In order that waste may be avoided, that the plant may be kept up-to-date, and that carelessness may be checked, some system must be employed by which the cost of the various items making up the total may be determined. A few of the features of a system, which I have adopted in several large buildings in New York may be helpful to others wandering in the same fog of difficulties.

The chief object of the system, originally, was to fix the cost per kilowatt hour of electricity in various types of buildings, in which private plants were in operation, and at another time I hope to give some of the results derived from the records kept. The original scope broadened of necessity, as fixing the cost of one item depends on determining the cost of the others. Cost keeping, as it applies to buildings,

has two objects: to raise the standard of production, and to lower its cost. To obtain the first object, it is necessary to know the results; and to attain the second, it is equally necessary that the cost shall be known.

To get this knowledge of results and costs, a system of "log" records, similar to those used on shipboard, will give satisfactory results, provided the figures are accurately noted and the results studied with intelligence. This log sheet, on which entries should be made at least hourly, serves the double purpose of showing the variation in the amounts of water used, current supplied, or coal fired, and of causing continual inspection of the plant and its operation. In addition to the hourly entries, the sheet should contain spaces in which can be entered the total amounts of raw material used, *i. e.*, coal, water, oil, etc.; the amounts of electricity, refrigeration, etc., or product manufactured and supplied, as determined by recording and integrating meters or by calculation. Record should also be kept of repairs, troubles of any kind, complaints, time spent in making repairs or changes, times of arrival and departure of employees, and the hours of operation of different pieces of apparatus.

On page 1085 is shown a blank used in an office-building plant containing a storage battery. The first columns show time of readings, number of gauges of water held in the different boilers, boiler and back pressures, temperature of feed water, coal used, and electricity delivered for lighting and for power. Reading these figures takes less than five minutes out of each hour, and insures an inspection of the plant twelve times a day.

The coal used is not measured hourly, although, for purposes of determining the effect of different kinds of load, the amount used per hour can be closely approximated. Instead, in this plant (which is a small one) a hopper holding from one-eighth to one-sixth of a day's supply is filled from a bin and emptied by dumping in front of the boilers. The time of filling, and the number of hoppers, are marked by the fireman, and the weight of coal figured from this. This is not as accurate as weighing, but tallies closely with the amount of coal delivered. In another plant the coal had to be wheeled into the fireroom, and a scale was sunk in the passage way. These methods are mentioned to show that the recording of results is a simple matter and does not involve expensive installation or use of time.

On the lower left-hand corner of the blank is the time sheet, on which times of arrival, departure, and total hours of working are noted, as well as the hours during which each important piece of apparatus is in use. Log blanks similar to this are found in several of

the building plants, but they are of little practical value for determining the cost of operation and amount of product, on account of inaccurate readings and careless entries. Their chief value is to insure constant inspection and to give a record of the hourly variation of product, which, in this particular building, is electricity.

To determine the cost and check the records, the usual log blank has been added to, and in the central space are columns in which are entered the totals shown by the recording and integrating meters, or obtained by other means, and the cost of the material and labor used in the manufacture of the plant product. The remainder of the sheet is used for notes as to repairs, complaints, accidents, or suggestions.

In hotels, apartment houses, or similar establishments, where refrigeration is supplied, blanks are used with additional columns for hourly readings of temperatures of incoming and outgoing brine and condensing water, head and back pressures of ammonia, brine, and water circulated. The readings upon the water serve as checks on wastefulness either of the machine or the attendants.

With the same object, indicator cards should be taken of the engines, about once a week at different periods of the day. To determine the cost, continuously recording instruments are necessary, and it is gratifying that the importance of these is becoming more widely recognized, and all large plants are equipped with them to a greater or less degree. When the installation includes boilers, electric elevators, electric lights and motors, refrigerating and laundry machinery, as in a modern hotel plant, the instruments required for intelligent supervision of the plant operation would be: a clock, separate water meters to measure water supplied to boilers, refrigerating machine, condenser, and house service (although the water supplied to the condenser will be used for both other services); recording steam-pressure gauge for high pressure; separate integrating watt meters for light, electric elevators, and large motors; ammeters and voltmeters to measure electric output; brine meter for circulating brine; thermometers for feed water, condenser water, incoming and outgoing brine, hot-water tanks, and engine and boiler rooms; ammonia high and low-pressure gauges; brine pressure gauge.

In small plants many of these instruments may be omitted, but in large plants they are a good investment and not a luxury. With the records of these instruments and a few constants determined once, carefully, for the plant, the calculation each day of the number of units of raw material used and product supplied is comparatively simple and will not take up over a half-hour of the chief engineer's time.

BUILDING.

DATE.

TIME.	WATER GAUGES.				PRESSURES. BOIL. BACK.	TEMP. F. W.	COAL.	AMPERES LIGHT. POWER.		MISCELLANEOUS.					
	1	2	3	4				0	0	CURRENT.	PRES. READ.	PREV. READ.	DIFF.	RATE.	COST.
6.00 A. M.	3	3			30	30		0							
7.00 "	2½	2½			90	110		30		Edison—Power	4,710,700	4,710,600	100		
8.00 "						140		300		Edison—Light					
9.00 "						170		500		Gas.					
10.00 "						190		500		Water	291,190	290,240	950	.10 per 100 ft.	.95
11.00 "								500							
12.00 M.								300							
1.00 P. M.								500							
2.00 "								500							
3.00 "								500							
4.00 "								500							
5.00 "								500							
6.00 "								500							
7.00 "								150							
8.00 "								100							
9.00 "								75							
10.00 "	3	3			30			50							
Totals								5,505							

TIME SHEET.

Total.....\$35.28

EMPLOYEE.	ARRIVE. DEPART.		MACHINE.	START.	STOP.	TOTAL.	REMARKS.	
Engineer.....	7	6	Boiler No. 1.	6	10	16	Voltage.....	240
Assist. Engineer.	7	6	" No. 2.	6	6	12	St. battery charge	
Night Engineer.	10	10	" No. 3.				St. without discharge..	
Fireman No. 1.	6	6	" No. 4.				St. battery discharge..	
" No. 2.	6	6	Engine No. 1.	7	6.30	11½	without charge..	
" No. 3.	10	10	" No. 2.	7	10	15	Total K. W. hours of	
Oilier ..	7	7	" No. 3.				dynamoes.....	1,519,500
El. Runner No. 1			" No. 4.				Average temperature	
" No. 2							of day.....	44¾
" No. 3							Cans of ashes.....	30
" No. 4								
Engineer.								

FORM OF LOG SHEET FOR OFFICE BUILDING, WITH STORAGE BATTERY.

Noting the number of pounds of coal, gallons of oil, or cubic feet of water, however, conveys but a hazy idea of the day-by-day operation of the plant, and for this reason the costs of material and labor for each day are figured up and recorded. The summary then shows at a glance excessive waste or trouble, and keeps the chief engineer keenly alive to the results obtained and the cost of carelessness.

The value of such definite figures has been shown and one instance may well be quoted: In a large building, pea coal had been used exclusively and cost, at the time the system was installed, \$3 a ton delivered. A new method of fuel burning was proposed by which No. 3 buckwheat or rice coal at \$2 a ton could be substituted. The plant engineer, called in by the owner, decided in the usual off-hand fashion that the change would not pay, for various reasons. The proposer of the plan persuaded the owner to a trial, stating, "You can measure the water delivered to your boilers and evaporated, and the coal used for a week, with the two kinds of coal; and if you don't save 20 per cent. I will remove the apparatus and replace the plant in its original condition, without charge." The proposition was accepted, and a saving of nearly \$2,000 a year effected.

The records by themselves, with careful study, can and do lead to improvement in the operation of the plant and reduction in the cost, as has been shown. For the decision of questions of original design, and of relative value of different kinds of service, the probe must go deeper, and the costs of each product should be determined as closely as possible. Where the product is varied, exact results are not obtainable, but the error can be reduced to one of little consequence.

It is necessary to consider the nature of the work done in buildings, in order to reach a basis from which the cost may be deduced. In the climate of New York the product of a complete plant in a building may be roughly divided into water supply, heating, lighting, building supervision, elevator service, refrigeration, laundry and kitchen work. The simplest type is that of a five-story building, without an elevator, in which only the first four items are to be provided; and the most complicated instance is a hotel plant of six or more stories in which all the factors enter. These products may be supplied from a central service or from a private plant.

In the five-story building, the heat may be furnished by steam or hot water from an outside source; the lighting by a gas company; and the water by city pressure. In this case the cost of heating a hundred cubic feet could be easily determined from the bill for steam, and the cost of water and light, in a similar manner, from the water and gas

bills. If no steam service was available, a boiler would be installed and the cost of heat would be the cost of the coal, water for boiler purposes, repairs and supplies, labor of running boiler, and fixed charges. If no electric service was available, and a plant was installed and the exhaust steam used for heating, the cost of the heat would not be changed and the cost of electricity would be the difference between the total cost and the cost of heating and building supervision.

If the building was eight-storied, the simplest case would introduce two additional factors—elevator service and water supply. The basic cost is again the cost of heating, etc., by steam from an outside source or from a private plant, regardless of the source of supply of the power for water pumping, elevator service, or electricity. This power may be, and generally is, supplied from an outside electric source, and the cost of each factor is determined by the amount of power and the character of the load. The same holds true in regard to the service from a private plant; the cost of the three factors is the difference between the total cost and the cost of heating and supervision of the building. This difference in a building plant is made up of the costs of coal, oil, water, gas or electricity from a central station for night service, sundry supplies, repairs, labor, and fixed charges.

For ordinary purposes the items of coal, oil, water, and central service, may be divided up among the factors in proportion to the amount of power used by them, as shown by the recording wattmeters. The labor, sundry supplies, and repairs, cannot be so apportioned. Each product must be charged with the repairs, supplies, and special labor (such as ice handlers and electricians) pertaining to the apparatus it requires. If electricity is required at night, and no heating, all the expense for running at night must be charged to electricity.

The cost of general labor in excess of that required for heating, such as that of chief engineer, assistants, and firemen, depends for its division, in my opinion, on the purpose of the investigation. If the object is to determine the unit cost for each factor in a plant of similar character, the cost of general labor could be apportioned between the various factors in proportion to the power used in their production. Such a figure would have a limited value, as the usual purpose of an investigation of this character is to determine the relative value of differing types of engines, boilers, grates, or other machinery, or the comparative costs of isolated-plant and central-service supply. With either of these objects in view, the cost to be charged to each product for the purpose of the investigation is only that portion of the general labor charges which would be reduced by the change proposed. For ex-

ample: it would manifestly be a mistake to include, in a comparison of the costs of artificial and natural refrigeration in a hotel, part of the chief engineer's services, unless with a refrigerating plant absent these services could be dispensed with or profitably used in other directions. To determine, therefore, the cost per unit of one factor, electricity for example, for purposes of comparing it with a central supply, it would be necessary to deduct from the total cost, including fixed charges on the mechanical equipment, the "basic" cost or cost of heating and building supervision, the cost of such labor as would not be affected by the absence of the electric plant, the fixed charges on such part of the whole equipment as would not be changed by the absence of the electric equipment, such proportion of the coal, oil, water, and central-service costs as the wattmeter records show not to pertain to the operation of the electric plant. That is: the cost of the electricity in a building is the cost of the special labor its production requires *plus* a proportion of the coal, oil, water, and central service used in addition to that required for the heating and building supervision, *plus* such part of the fixed charges and repairs as is directly chargeable to the manufacture of electricity.

It is impossible to take up each type of plant in a paper of this kind, and as the general principle of the log sheet has been explained, the other parts of the system may be touched on briefly. It is important that the cost of the several items of the plant be kept separate, and I use a sheet divided by fifty-two horizontal lines and vertical lines in which weekly record is made under separate headings of coal, oil, waste, labor, engine repairs, boiler repairs, etc. The record of each plant for a year is thus kept on a single page, and comparison of one year with another is a simple matter. In addition to this account there are usual ledger and journal accounts.

To obtain supplies the chief engineer makes out once a month, and at other times when necessary, a duplicate requisition blank, one copy of which is forwarded to the office. The order is sent out, a duplicate being retained, and the material received is checked on the duplicate requisition blank, which is in turn forwarded to the office where it is compared with the order. This system checks extravagant demands and allows of competition in buying. Reports of daily operation with the summaries are delivered weekly to the office and the results tabulated. Bills are entered on receipt and the items distributed under the separate headings, after which they are filed in divided envelopes under the initial of the firm sending them. Bills are always in duplicate and separate for each building.

EDITORIAL COMMENT

The death of the Queen, which occurred shortly after our preceding issue was off the press, has called forth an expression of sympathy and respect most impressive by its universality and its depth. It affords a striking exhibition of the growth of international friendship under the influences of the era of industry—the period of the transfer of national rivalry from the political and military to the economic field. This period, practically almost coeval with the Victorian era, has witnessed the rise of substantially the whole existing system of mechanical production and transportation. It will be recalled that the Queen accepted the Bessemer gold medal of the Iron and Steel Institute in 1899, in commemoration of the marvellous advance in the iron and steel industry during her reign—advance that has amounted to complete reconstruction of plant and methods. The same period saw the first crossing of the ocean by a steamship, saw the growth of the railway, the introduction of the telegraph, the cable, the telephone, the utilisation of electric power, the differentiation of mechanical and electrical engineering as separate professions, the advance of the engineer to the place of foremost importance in modern economy.

* * *

But even more significant than this material change is the change of attitude in the matter of foreign relations which has accompanied it, and in large measure resulted from it. Fast-spreading lines of travel, of communication, of trade, have brought the nations together and promoted understanding. Common interests in foreign trade have led to common action. Competition has fostered mutual study, and has assimilated practice and with it customs and institutions. And in the general interchange of experience, first,

and of sympathy next, a large value must be attached to the influence of the international exposition, of which the idea was first conceived and carried into execution by the late Prince Consort.

* * *

To the outside world the most impressive lesson of the Queen's death is the magnificent stability of British institutions and the British commercial system. Not a wheel stopped, save as a token of reverence; not a tremor in values disturbed financial centres; not an uneasiness or uncertainty as to national politics caused business undertakings to waver or hesitate. Compare this with the quadrennial upheaval in the United States, where economic legislation of every kind is the football of politics, and industry follows with uncertain feet, now artificially raised on an unstable platform of protection, now shrinking back from the morass of free silver, certain of nothing but uncertainty with every change of Chief Executive. The "demise of the Crown" demonstrates anew England's industrial strength, and those who are ready to cry her downfall before her industrial rivals would do well to remember that this stability of commercial organisation outweighs much mechanical aptitude. Machinery can be bought; skilful brains and hands can be hired; but stable political and commercial systems are of slow growth, and not soon attained.

* * *

Opinions of the value of a technical publication vary, as is the case with many other things, according to the view-point of the observer. The general reader is impressed with the manner in which interesting information is presented; and if an abstruse subject can be placed before him in an agreeable manner, he is quite

willing to be entertained while he is being instructed. The professional engineer looks for substantial information in his especial line, boiled down to the strongest degree of concentration.

The business man desires knowledge of what others are doing, and also wishes to advertise to the world his own business and his own capabilities to perform his share of the work of the world.

All of these classes of readers find ample provision for their requirements in the pages of *THE ENGINEERING MAGAZINE*. In the illustrated leading articles are found contributions upon subjects of immediate general and special interest, from the pens of the foremost specialists of four continents, embellished with the most brilliant work of camera, engraver, and printer. In the Engineering Index the entire field of technical literature is spread out before the worker in every department of engineering, placing him in direct touch with current thought and labour; while in the Review of the Engineering Press, the notable articles of the month, coming from England, America, or the Continent, are condensed, translated, reviewed, and criticised with care and discrimination, yet without fear or favour.

To these distinctly literary and scientific departments is added a fourth, consisting of the advertising pages, filled, it is true, with announcements of a distinctly proprietary nature, heralding forth the wares of manufacturer, engineer and merchant, yet possessing a peculiar value for all who desire to keep in touch with the vast world of business dominated by engineering interests and engineering developments.

Having provided these departments for all classes of readers, *THE ENGINEERING MAGAZINE* adheres strictly to the fundamental principle of maintaining each entirely distinct from all the others. Leading articles are prepared or accepted solely because of their bearing upon subjects of current or vital interest, regardless of the fact that there are advertising pages in the magazine, or even such things as advertisers in existence. The fact that the interests of an advertiser may be affected

favourably or unfavourably by the statements in a leading article, or the criticisms of a review, has not the slightest bearing upon their consideration or publication.

It has seemed necessary to say these things at this time because unfortunately the habit of reasoning by analogy, although eminently unsafe as a mode of thought, sometimes leads business men of otherwise acute discrimination to suppose that *THE ENGINEERING MAGAZINE* permits its pages to be used in a manner to which they had become accustomed elsewhere. The idea that an advertisement becomes more valuable when disguised may permit a business man to attempt to secure such equivocal privileges; but it is only necessary to point out the uselessness of such attempts to call forth acknowledgments of appreciation of the value of the high standard set for itself by *THE ENGINEERING MAGAZINE*.

The following letter, from a high official in a leading engineering firm, is an excellent example of the manner in which the standard of the Magazine is appreciated:

"Instead of expressing annoyance at your declining to publish our paper in the Magazine, I shall have to say that I quite sympathize with the position you take. If *THE ENGINEERING MAGAZINE* were conducted on other lines than those you have laid out for it, we should probably not be carrying an advertisement in it, nor would we find ourselves especially desiring the good things we have to make first appearance in its pages. If 'write-ups' and other forms of concealed advertisements were excluded from the news pages of all engineering and trade journals, a very distinct advance would be noticeable. We should have better papers and fewer."

THE ENGINEERING MAGAZINE pays for all contributions to its pages at regular and established rates, the position of articles is governed by their importance and not by the remotest trace of business influence, and every approach or suggestion of such influence is met by communications similar to that to which the above letter is a response.



REVIEW OF THE BRITISH PRESS

Electrical Oscillations and Waves.

THE development of the theory of wave action in physics generally and the many practical applications made of late of electric oscillations and waves, render the Cantor lectures of Dr. J. A. Fleming, published in the *Journal* of the Society of Arts, most timely and interesting.

Dr. Fleming treats the subject in a thoroughly scientific manner, and yet makes it as popular as such a distinctly technical matter can be made, and his clearness of expression and the apposite nature of his illustrations are characteristic.

As in many other classes of phenomena, the controlling properties of electric currents vary with the nature of the current. In the case of continuous or very slowly periodic currents, the chief attribute of the circuit claiming attention is its resistance. The moment we begin to employ alternating currents of even moderate periodicity, the inductance begins to be important. As the frequency rises, we find that a third property, viz., the capacity of the circuit, makes its presence felt.

Professor Fleming considers first the practical method of producing electrical oscillations, and shows that while waves of moderate frequency can be produced by moving bobbins of wire to and from magnets, that this method ceases to be applicable above a frequency of a few thousand, because of the impossibility of creating the requisite mechanical movements with sufficient speed. In order to produce very rapid oscillations, another method is employed. This method is based upon the fact that when two conductors, previously brought to a large difference in pressure, are suddenly connected by a conductor of low resistance, there is set up a current of very high frequency, which gradually dies away. This action is similar to the oscillations produced in a U-tube containing mercury, for example, in which a suddenly relieved pressure in one leg will cause the

level in both legs to oscillate a number of times before equilibrium is established. It is evident that this property, combined with some mechanical or chemical method of making a great number of interruptions, enables an extremely high frequency to be attained. Professor Fleming describes the arrangement of such apparatus in detail, but we have here only space to discuss some of the effects of the oscillations thus produced, together with the methods of controlling them, and to describe some of the practical applications which have thus far been made.

By the use of Leyden jars, or similar condensers, the discharges may be produced, and Professor Fleming describes the manner of connecting the condenser with an induction coil and interrupter, so as to obtain the necessary difference of potential and frequency of oscillation.

Passing from the production of oscillations to the utilisation, Dr. Fleming discusses electric resonators, and the method of "tuning" two systems so that the one will respond to oscillations set up by the other, while systems not in tune will not respond.

In the discussion of the mathematical analysis of Maxwell, the question of the electromagnetic medium is taken up, and it is shown how the observed phenomena prove that physical changes produced by one body in another at a distance can only be due to actions taking place successively at contiguous points in an intermediate medium. In other words, that there can be no such thing, strictly speaking, as action at a distance. This brings up the subject of dielectrics, in connection with which Dr. Fleming gives an account of some interesting experiments conducted by Professor Dewar and himself upon the behavior of various substances at very low temperatures. These researches showed, among other interesting facts, that liquid oxygen possesses four qualities found together in

no other substance, namely, optical transparency, almost perfect non-conductivity, a magnetic permeability greater than unity, and a dielectric constant nearly 50 per cent. greater than that of empty space. Measurements made upon ice, frozen alcohol, frozen glycerine, and many other frozen liquids showed that in all cases cooling them to a very low temperature destroys entirely their otherwise high dielectric values.

The greatest practical value of electric waves, however, is the use which may be made of them for the transmission of intelligence without the necessity for a metallic conductor. The results of the studies of Hertz appears in the so-called "wireless telegraphy" of Marconi, or as Professor Lodge prefers to name it, "space-telegraphy."

The "oscillator" of Hertz, may be understood by the diagram, the current in the primary coil inducing a difference of potential in the knobs terminating the secondary coil until the air insulation between

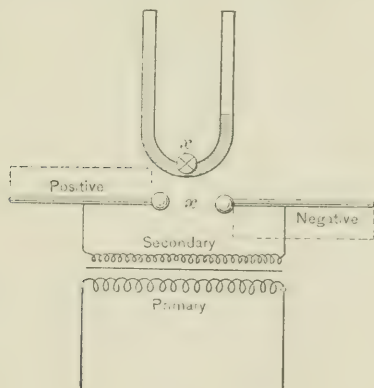


FIG. 1.

the balls breaks down, and it becomes highly conductive. Then the whole radiator becomes one conductor for the moment, and the potential difference begins to equalise itself, a current flowing from one side to the other and creating a magnetic flux, which in turn persists and recreates electric displacement in an opposite direction. The U-tube shown over the air-gap in the sketch is intended merely to illustrate the production of oscillations by the sudden release of a strained material body.

With this apparatus Hertz used a resonator, consisting of a nearly closed ring of wire, the ends being provided with metallic balls very close together. When this resonator is placed in the range of the waves emitted by the oscillator, sparks will be produced between the balls of the resonator when the two devices are in certain relative positions. Employing these two devices Hertz found that the waves were capable of reflection and refraction, using prisms and lenses of paraffine and similar material, and in many experiments demonstrated the similarity to waves of light, heat, etc.

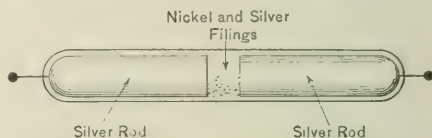


FIG. 2.

In describing the coherer, as used by Marconi to receive the impulses of electric waves, Dr. Fleming shows that the idea of employing a tube, loosely filled with metallic powder, was due to the late Professor Hughes, in 1879, but that it was Branly, in 1891, who first examined the subject with sufficient care to discover its possibilities. The most satisfactory results have been obtained by Marconi with a coherer similar to that shown in the illustration, in which a very minute amount of nickel and silver filings is included between silver plugs, only one-fiftieth of an inch apart, sealed up in a vacuous glass vessel. The passage of an electro-magnetic impulse over such a tube causes it instantly to become a conductor while it is at once brought back to a non-conductive condition by tapping or shaking.

Marconi, therefore, by skilful practical application of the Hertz oscillator and the coherer of Hughes and Branly, has been able to communicate over space without the use of conductors, as has already been widely made known. This, however, is only one of the practical uses to which electric waves may probably be put, and there could be no better preparation for the student of such phenomena who may be disposed to push forward into a most inviting field of research, than a careful perusal of Dr. Fleming's admirable lectures.

Technical Education.

IN discussing the requirements of the twentieth-century engineer, and in subsequent remarks upon the relation of education to competition, *Engineering* makes some editorial remarks which will well bear comment.

"If one thing can be more surely predicted than another it is that the conditions of the future will be more exacting than those of the past. Engineers have uncorked the bottle, and let out the demon of technical education; and those who accomplished their pupilage before its advent had better make haste to grow old, and retire on their laurels—and their incomes, if they have made them—before they are smothered by the flood of learning that has been let loose. This, of course, does not apply to engineers who have made their position secure, or can bring a knowledge of affairs to the direction of a business and to exploiting the many bright young men who are only too anxious to be exploited at a sufficient salary. In all ages, however, those who can manage men and direct human efforts have taken, and will take, a higher place than those who manipulate materials. That will be true to whatever pitch technical education is brought; for as the man is a more subtle instrument than the machine, so must the operator of men have higher gifts than the operator of mechanism."

But technical education, as administered by the professors, is by no means necessarily a good thing. On the contrary, many young men who have gone through a college course with credit and distinction are often useless as engineers, and it may well be questioned if all the value which the educational institutions have given to the profession could replace the work of Watt, Stephenson, and Bessemer.

A great defect, it may be called, *the* great defect, of the present system is the inability to sort out the students according to their mental capacities and characteristics; the rowdy incompetent being, of course, weeded out altogether. The erection of a tottering superstructure on an inadequate foundation is too often the consequence of the present method of carrying a number of students of varying capacity forward at the same rate. The existing ex-

amination system makes it impossible to obtain the real average of the work of a professor. Ambitious of seeing his results high on the list, the instructor often devotes himself to three or four of his brightest pupils, and the rest do not count. If the rest really did count, if it was the professor, and not the student, who received the marks, his marks being an average of the work of all his pupils, doubtless his work would be more equably divided, especially if the results were made the criterion by which his position were determined.

"The engineer of the twentieth century will have need of all the knowledge education can bring. The nineteenth century skimmed the cream of invention; what was on the surface has been appropriated. James Watt made it impossible anyone else should have quite so brilliant a record as himself, and yet his master-stroke of invention, the separate condenser, did not need abstruse scientific attainments; although Watt was essentially scientific in his methods. So each successful worker in the field of invention does something to exhaust the soil, and render needful higher fertilisation for further productiveness. New vistas, however, are constantly being opened out, and, to continue our analogy, we have something like the rotation of crops in the changing instruments by which the engineer attains his ends.

It is becoming more and more evident that the day of the uneducated engineer, the man who by mere force of genius accomplished results which have changed the face of nature, is being replaced by the epoch of the skilled master of methods in applied science. The great surface mines have been worked, although the tailings still contain much valuable material, worthy of careful extraction. Down deep in the lower strata, however, is riches doubtless far surpassing that which has already been obtained, but it can only be reached by the keenest tools, wielded by the ablest hands.

"Whatever may be the national values of the genius and the competent man respectively, it is evident that the country that has both must be the best off. In the matter of education, what is likely to produce the competent many will also develop

the select few, supposing a proper sifting out be observed. But genius is rare, and, indeed, the simply competent are rare, so that the net must be spread wide to secure the talent that the country produces. It is here that Great Britain is falling behind many of her competitors, and the developments of the last ten years emphasise this strongly. In regard to technical education—using the term in its broadest sense, and not as confined to the schools—we, in this country, have had an incalculable advantage up to within the last few years. Every engineering factory in the kingdom has been, in the past, a school for technical education of the most efficient sort. All the academies of the Continent could not alone vie with our workshops in training mechanics and mechanical engineers, and so long as we retained an overwhelming preponderance of workshops, our engineering supremacy was assured. But from small beginnings the Continental factories, and still more those of America, have worked up to establishments of large size, employing vast numbers of men, and this, combined with the higher technical training abroad, has made extensive inroads into our former exclusive markets."

It is evident that more technical education of the kind already mainly in vogue is not needed. Carlyle has said that a king is a man who *can*, and to train up men who can, first selecting the material, and then using methods which shall arm the competent with the most powerful tools to aid him in his attacks upon the resources of nature, this is the scope of modern technical education, and the nation which does not provide it must expect to be distanced in the race by the nation which does.

Electricity in Warfare.

We have frequently referred in these columns to the important share borne by the engineer in modern warfare, and the interesting lecture delivered before the Institution of Electrical Engineers by Lieut. Col. R. E. Crompton, upon the work of the electrical engineer in South Africa, published in a recent issue of the *Electrician*, is but another instance of the manner in which applied science has been pressed into service.

The most important electrical work

which it was expected the corps would be called on to perform in South Africa was that of providing electric lighting in connection with the work of the engineers, and the equipment consisted mainly of portable searchlights carried on carriages somewhat similar to those used for field artillery guns, the electrical energy being generated by dynamos carried upon compound steam traction engines. Additional electric-lighting apparatus was also carried, as well as special cable carts. A novel feature of the equipment consisted of twenty bicycles, provided with reels on which fine uninsulated copper wire was coiled, to serve as telephone conductors, and a special light and very portable type of telephone was carried. The remainder of the equipment included complete sets of repairing tools, tube wells, pumps, portable forges, etc., and experience showed the whole outfit to have been well chosen.

An early, and important part of the service of the corps soon after its arrival at Cape Town, was the construction of field telephone lines to replace telegraph lines destroyed by the enemy. This work included the maintenance of telephone communication with a flying column advancing from Bethulie to Smithfield, $1\frac{1}{2}$ miles of bare copper wire, No. 22 gauge, being laid on the ground from bicycle reels.

Another important and immediate branch of work which was successfully executed was the lighting of the bridge construction work at the Vet river, where the railway construction corps of the Royal Engineers was engaged in building a main bridge with long approaches and three smaller bridges. The efficient service rendered by the electrical corps made it possible to work all night, and thus very materially hastened the completion of this undertaking. Similar work was also carried out at the Zand river, and at Rhenoster Spruit, the corps also rendering much useful service at the latter point in general engineering work.

Besides all this electrical and civil-engineering work, the corps had its share of military service, and must by no means be considered as non-combatants. For eight days the detachment was actively engaged at the front while the enemy under De Wet and Theron were threatening the line of

construction works. At Leeuwspruit the construction train was partly derailed and then attacked by Boers in ambush, and for a number of hours the electrical engineers were actively engaged in defending their outfit, which, from its importance, the enemy made desperate efforts to destroy. Instead of attempting to defend the train as it stood, the electrical engineers and other troops under their command took up a position on a ridge of rocks which ran transversely to the train, from which the train could be protected without the men being exposed. This position was held for several hours, and was so strong that the Boers could neither dislodge the troops nor approach the train, and after daybreak they withdrew from the attack. If De Wet had been successful in this attempt, securing the construction material and tools, as well as the most skilled body of reconstruction officers, the break in the line of communication would have remained open for a long period, and would have seriously affected future movements.

After arriving at Pretoria, the engineer-in-chief found quantities of electrical work for the corps, as all the forts which defend the town had been fitted up with various electrical apparatus, not only for electric lighting, but there were signal materials, telephone and other wires, which required to be sorted, labelled, and their uses understood. The oil engines which supplied the motive power for driving the dynamos had purposely been damaged by the Boers, and had to be repaired and set to work. The small and inefficient searchlights which had been used by the Boers were replaced by a system of incandescent lamps placed so as to illuminate certain points which were liable to be threatened by the enemy during night attacks.

Much of the subsequent work performed by the corps partook of the nature of general engineering, and the possession of the traction engines proved a valuable help in many ways. Several times an engine which was being used to haul 12-ton 6-in. quick-firing guns near Pretoria became stuck, and had to be assisted, and as a result the engine and two guns were placed in charge of the corps, and most efficiently handled in most difficult and important positions. Ultimately a regular steam trans-

port service was established, using five traction engines and demonstrating the vast importance of these machines in warfare, especially in country of bad roads and scarcity of horses.

The whole work of the electrical corps, as described by Lieut. Col. Crompton, must be considered as a most important lesson in the application of engineering to warfare. Where time is of such vital importance as in military operations, the electric light must henceforth be considered as an absolute necessity. The telephone, with flying connections made by bicycle, has demonstrated its availability. In future campaigns we may expect to see electric motors pressed into service, and manual labour in many instances replaced by machinery. The traction engine will be far more generally used than heretofore, and doubtless other motor vehicles will be employed. With all this engineering work, it can also be fully understood that engineers are fighting men, and can not only perform their own special duties promptly and well, but be depended upon to defend their equipment bravely in the face of the enemy, and rank among the "all-round men of the service," the kind of men an able commander delights to have. The keenness of perception, and ready resourcefulness of the engineer makes him most eminently qualified to be a soldier in every sense of the term.

Engineering in the Nineteenth Century.

As is customary in the first issue of each year, *The Engineer* devotes much space to a review of engineering progress in the year just closed, and at the present time this review is extended so as to include a rapid retrospect of the work of the engineer in the nineteenth century, the century of which it has been truly said that it was the first in which engineering exercised a dominating control. The century has been remarkable in very many ways, and the lessons to be learned must be presented to mankind through various mediums.

"The most noteworthy, the most impressive, of these lessons are the character, the nature, and the importance of the work done by engineers—we use this title in a very large sense. That work has con-

sisted, directly or indirectly, entirely in facilitating intercommunication. The energy of the engineer has, if we may use the phrase, been wholly kinetic. He appears invariably as the man who is making something move, or who is providing means to cause movement to take place. The mechanical engineer gives us the locomotive and the train. The civil engineer gives us the road on which they may run. The road is *the* great civiliser. Just in measure as civilisation extends, so does the demand for means of intercommunication. First came the highway. Next the canal. Then the railway. So much for the transfer of substance. The letter, transmitted by the runner, or the horseman; then by the stage coach; lastly, by the railway train, represented the primitive method of transferring thought. Next came the telegraph. That was followed by the telephone, which annihilates distance for audible speech. Last of all, for the moment, is the wireless telegraph. One step more, and the voice will be reproduced by Hertzian waves. We shall have the wireless telephone. We are within quite measurable distance of that consummation. But these and all other things like them have the one purpose and object in view. Their sole function is to facilitate inter-communication. The steamship, the railway, the telegraph, all work to the same end. What that end is can best be realised by supposing that we are suddenly deprived of them. It is said that the population of England was about 8,000,000 one hundred years ago. We know that these 8,000,000 were precariously fed. We know that famine now and then stalked through the land. The first importation of corn from the United States into this country on anything like a commercial scale took place about the year 1848, when a Belfast firm of flax spinners imported a cargo of about 600 tons of maize into Ireland, where famine was killing its thousands, not so much for lack of money as for lack of food to buy with it. Thirty millions of people could not exist in Great Britain without the aid of the steamship. Our great towns would be impossible without the railways. The fact that the important work of the country has had for its be-all and end-all locomotion—locomotion of

men, animals, food, water, sewage, gas, thought, is constantly forgotten. It is in a way curious, too, to note what a very few inventions, apart from that affecting locomotion, have played an important part in civilising, received any very great attention, or made any very considerable demands on ingenuity or skill. Not a fraction of the energy expended on the transport of corn has been expended in improving the methods of its growth. Inventions concerning the comfort, the housing, the warming, the sanitation of mankind have never received the honours or conferred the awards given to aids to locomotion."

The principal result of the work of the engineer, looked at from this standpoint, is the closer union between various parts of the world because of the possibilities of transport. England long since ceased to be able to supply her population with subsistence, but the tramp steamer has brought India, America, and Russia to her doors. The material advantages of various nations are rapidly becoming the heritage of all the world, the transportation element becoming proportionally less and less important as a factor in cost. That this state of affairs involves a redistribution of industries must necessarily follow, but while intercommunication work ill for certain sections of the community it works for the greater good of all mankind.

"Thus the English agriculturist has suffered, because he depended for prosperity on the isolation of the country. But even the farmer himself begins to see that he has not suffered for nothing, and that even his life is not without recompenses and satisfactions. There is, however, one national advantage which is largely independent of the means of transport, and which is, we think, the unfailing heritage of the people of this country and of her sons and daughters distributed all over the globe. It is that world-surprising combinations of audacity, sagacity, endurance, talent, and genius, which seems to be the birthright of our race, and the certain means of maintaining Great Britain's position. Furthermore, if this little island disappeared tomorrow, so long as its population remained alive the world would not lack rulers of men, masters of nature, and supporters of right. It is with no pessimistic spirit that

we begin a new century, though foreign competition may threaten us at home and abroad. We know that, like the mills of the gods, though Britons grind slowly, they grind surely. With each difficulty will come the way of escape."

The reviews of the various branches of engineering as it exists at the close of the century give an excellent idea of the position of man with regard to the forces of nature, showing how he is prepared to make the attack anew, and along what lines progress may be expected.

In civil engineering, bridge work showed no new development, but has continued along lines already well developed. Subways and tunnels, especially for metropolitan traffic, have made notable progress, as in London, Paris, and New York. Railway developments in all parts of the world have been progressing, carrying trade and civilisation with them: witness Siberia, India, and Africa. Water supply and sanitation are making good progress, and would advance more rapidly if they depended solely upon the work of the engineer unhampered by the politician.

Mechanical engineering has progressed well. The steam engine, thanks to the possibilities of electrical distribution of power, is being made in larger and more efficient units than ever; the water-tube boiler is firmly established both for marine and stationary service. The internal combustion motor, whether for use with gas or liquid hydrocarbons, has made long strides, and the capacity of large engines has advanced from 200 or 300 horse-power to 1,000 horse-power and over for single-cylinder motors, while the use of furnace gases has become an established fact. Locomotives are heavier and more powerful than ever. Artificial refrigeration is meeting with extended applications. Mechanical engineering is extending its realm more and more into other lines of practice, and it is evident that it is destined to absorb nearly every department of engineering industry.

In electrical engineering there is little to record in power applications, except to enumerate a list of hydraulic and other generating stations, with their transmission and distribution systems. Communication has had added to its resources improved high-speed writing telegraph de-

vices, and the range of long-distance telephony has been greatly extended, while submarine telephony has come within the bounds of possibility.

The advance in metallurgy has mainly been along the line of greater productivity, and the enormously increasing use of steel in all branches of construction continues.

All departments of engineering have been developed to an extent hitherto unprecedented, and the dependence of the material progress of the world upon the work of the engineer was never so fully emphasised as at the close of the nineteenth century.

Coal Cutting by Machinery.

WITH the increasing price of coal has come a general interest in methods for cheapening the cost of mining, and hence it is not surprising that the use of coal cutting machinery should be the subject of various articles in recent issues of the *Colliery Guardian*. A series of editorial papers, beginning with a historical introduction and following with examples of practical application, forms a very practical contribution to the subject of modern coal mining. Without attempting to go into detail, the advantages of coal cutting machinery may be briefly enumerated.

In the first place, the machine possesses the ability to do the work at a smaller cost than is possible with hand labour, and this is true whether in long-wall, or pillar-and-stall working, as well as driving headings. A comparison of costs at various collieries shows the saving to range from 4d. as a minimum to 3s. per ton, a fair average being one shilling per ton.

Since the cost of cutting by hand varies with the character of the seam, it follows that the greatest economy results from the use of machinery in thin seams, but it is from this class of seams that future supplies must be largely drawn. An extreme instance of this is found in a case where Messrs. Gillott claim to have won a seam of valuable cannel, only 3 inches in thickness, in which the cutting price by hand ranged from 20s. to 14s., at an economy of just one half, by the use of machines.

The wastage by the use of machinery is also much less, and the time element should also be considered for other reasons than those of mere labour cost while the hu-

manitarian side of the question is one which stands by itself in importance.

The colliery, like all other branches of human industry, must surely yield to the pressure for the replacement of human labour by machinery, and there is no department of work in which its advent should be more heartily welcomed.

Electric-Power Distribution.

ELECTRICAL distribution of power has frequently been treated from the standpoint of the electrician, and for this very reason the paper of Mr. W. B. Esson, upon the case for electric-power distribution, presented before the Civil and Mechanical Engineer's Society, and published in the *Electrical Engineer*, is especially acceptable.

Leaving out of consideration the problems of transmission, Mr. Esson confines himself to the question of electric distribution of power in workshops and factories, and relegating to the electricians the discussion of the relative merits of continuous and alternating currents, he considers mainly the subject of the displacement of the older methods of transmission by the newer.

Taking up first the mechanical methods, so-called, for the distribution of power, their inherent wastefulness is clearly shown. Small steam engines are necessarily uneconomical, even when in perfect condition, while as actually employed they are far more wasteful than any other practical form of power subdivision.

The losses in shafting and belting have often been investigated, and while there are necessarily many variations, it appears in general that the loss ranges from 40 per cent. at full load to more than 70 per cent. at quarter load.

The margin for economy is therefore great, and it remains to be seen to what extent electrical subdivision and distribution of power can be expected to show a greater saving.

Taking a direct-connected generating set, the dynamo being mounted on the engine shaft, a useful return of 90 per cent. may be expected in the form of electrical energy, and allowing 10 per cent. for engine friction, we have at the generator terminals 81 per cent. of the indicated horse power of the engine, taken at full load. For part loads the efficiency falls off to about 71 per cent. at

half-load, and 56 per cent. at quarter load. A similar relation exists as to motors, except that the use of a number of motors permits the safe assumption that the mixed sizes and loads will give a general average efficiency, which is decidedly higher than is attainable with shafting and belts.

By means of a diagram of motor efficiencies Mr. Esson shows that for full load an efficiency of 66 per cent. is obtained for electricity as against 60 per cent. for shafting, while at quarter load we get 44 per cent. as against 27 per cent.

Coming as this endorsement does, from a civil engineer, before a society of civil and mechanical engineers, it is worthy of especial consideration, as being free from bias or prejudice.

Submarine Boats.

SUBMARINE warfare has so many attractions to the popular mind that it is with satisfaction that we note the appearance in the *Engineer* of papers showing what has really been already done in this direction, and what the possibilities really are. As a matter of fact there are certain limitations, which should be appreciated before either undue alarm or undue enthusiasm is excited.

For a full discussion of the subject the reader must be referred to the papers above mentioned, but the salient points may be here enumerated.

High speed is a practical impossibility, because submarine navigation requires more power than similar displacement demands at the surface, while there is far less space available for motors. The limitations of steam are well known. Oil motors of the internal combustion type require even more space for equal power, while electric storage is also handicapped by bulk and weight, as well as necessity for frequent charging. Carbonic acid, or liquid air might be employed if their claims could be made good practically, but at present they do not respond to the demands of the service.

Bearing these points in mind, the *Engineer* proceeds to examine the performance of existing boats, mainly with a view of finding out what they cannot do; a laudable object, with the one weak point that no logical conclusions can be drawn from negative premises.



REVIEW OF THE CONTINENTAL PRESS

Multiplex Space Telegraphy.

ALTHOUGH "wireless" telegraphy has been in public use for several years, and has been found very serviceable for communicating with ships at sea, and with isolated stations not to be reached by cables, a serious objection to its more general employment has been the lack of any selective system of signalling.

A train of waves sent out from a station would influence all the receivers within the transmitter's radius of action, and, conversely, a receiver was subject to the influence of all the transmitters within its range of susceptibility. This meant, practically, that only one instrument could "speak" at a time, for if two stations tried to communicate simultaneously with a third, there resulted an inextricable confusion of signals.

Naturally, the workers in space telegraphy have long striven to overcome this difficulty, but it has remained for Prof. Slaby, of the Charlottenburg Technical High School, to reach a solution of the problem, at once scientifically elegant and beautifully simple.

It may be remarked, in passing, that he was induced to undertake his experiments by the desire to provide the German navy with a system of wireless telegraphy which would not conflict with the Marconi patents, as the English Marconi company demanded a price for the use of its system which the German government was disinclined to pay. Prof. Slaby investigated the subject in a thoroughly scientific spirit, and while in the beginning he hoped for nothing more than to devise methods which would be as good as Marconi's, he has now gone far beyond anything hitherto attained in the field of "spark telegraphy," as he prefers to call it.

In a lecture delivered in Berlin before a distinguished audience, including the German Emperor, and reproduced in a recent number of the *Electrotechnische Zeitschrift*, Prof. Slaby has given an interesting account

of his inventions, the leading points of which may here be briefly touched upon.

The lecturer, after a general introduction, gave a mechanical illustration of vibratory motion. If a steel rod has one end clamped in a vise, and the free end be struck, the rod will execute regular vibrations, the amplitude of which will be greatest at the free end and diminish to practically zero at the fixed point. These oscillations can be communicated beyond the fixed point by clamping a wire at its middle, and setting one free end in vibration, when the other free end will execute vibrations of the same rate and amplitude. Considering this as a case of wave motion, the free ends constitute loops and the fixed point is a node, the distance from a node to a loop being just one-quarter of a complete wave length.

Now in space telegraphy there are electric oscillations set up in the vertical wire at the transmitting station; the frequency of these oscillations, and consequently their wave-length, being determined by the length of the wire, which, as in the case of the steel rod, will be one-quarter of the complete wave-length. These waves are propagated outwards through the ether and when they fall upon the receiving wire, they set up oscillations therein, which are most powerful when the wire's natural rate of electrical oscillation corresponds with the frequency of the incoming waves. This will be the case when the wire is just one-quarter of the wave length and when its lower end is a nodal point. The length of the wire can be determined with great exactness and its lower end can be made a nodal point of the electrical oscillations by connecting it directly to earth. In this way the favourable conditions for great amplitudes can be attained; the lower point being earthed, will be at zero potential, while at the upper free end of the wire the rapidly oscillating potentials will be highest.

It would appear, then, that in order to get the best results, the receiving apparatus

should be at the free end of the wire. This requirement has apparently not been recognised hitherto, for the coherer has always been connected to the lower end of the wire, or at the point of minimum effect. That the apparatus has worked at all is due partly to the extreme sensitiveness of the coherer and partly to the circumstance that the lower end of the wire will not be exactly at a nodal point for the fundamental wave length unless the wire is of the same length as that at the transmitting station, and even if the length of wire be the same at both stations, there will be harmonics impressed on the fundamental wave which will cause irregular oscillations on the receiving wire sufficient to affect the coherer. The dependence of the coherer upon these irregular oscillations is probably accountable for its erratic behaviour in the systems hitherto in use.

There are, of course, practical objections to placing the coherer at the upper free end of the wire, but Prof. Slaby attains the same result by simply prolonging the wire an equal distance beyond the nodal point. This extension wire need not be straight, but may be wound on a reel, and at its free end, which can be placed in any convenient position, there will be developed oscillations of the same amplitude as at the upper free end of the vertical receiving wire, and the coherer, placed at the free end of the extension wire, will get the full benefit of these great amplitudes.

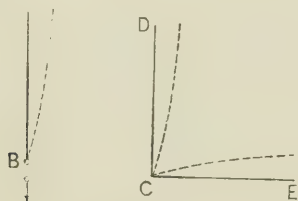


FIG. 1.

In the accompanying diagram, B is the vertical transmitting wire, sending out waves four times as long as itself; CD is the vertical receiving wire, directly earthed at C and thus forming a node at that point, but also prolonged beyond to E, CE being made equal to CD. The potentials at E will be as great as at D, and a coherer placed at E will get the maximum effects of the oscillations.

The extension wire is the essential part of Prof. Slaby's invention, and besides

greatly improving simple transmission, it makes possible the long-desired multiple signalling. The arrangement of wire just described will respond to waves of only one length. Waves of all other lengths will go to earth at C, which is not a nodal point for them, and will never reach E.

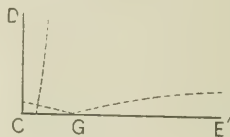


FIG. 2.

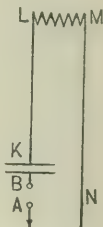


FIG. 3.

But it is found that if another extension wire, CE', be joined to the lower end of the air-wire at C, so that the total length of air-wire plus extension wire is just half of the new wave-length, then a node will be formed at G, midway between D and E', only a negligible part of the new wave's energy will go to earth at C, and maximum oscillations will be produced at E'.

In this way it is possible to simultaneously receive as many messages as there are extension wires, each of the latter plus the air-wire, being of a length equal to half that of the waves emanating from the corresponding transmitting station.

It only remains now to provide a transmitting apparatus which shall send out waves of a given length. Prof. Slaby reaches this result in a way by which he obtains powerful oscillations, as well as absolute control over the wave-length.

Instead of a single vertical insulated wire, he has a circuit, grounded at N, the branch MN being connected to the actual transmitting wire through the induction coil LM. In charging, the whole circuit is used, and a large amount of energy thus made available, but when the rapid oscillatory discharge takes place, the choke-coil LM allows no oscillations to pass through it and only that part of the circuit between K and L is effective in sending out waves. The length of these waves is completely determined by the length of wire between K and L and the capacity of the condenser at K.

It is apparent, then, that there is entire control over the wave-length, that receiving

apparatus can be perfectly tuned so as to respond to only one wave-length and that at a single station there may be any number of receivers, each actuated only by its corresponding transmitter. Complete secrecy of transmission is thus attained, unless the wave-length of the transmitter be known, and any number of messages may be received simultaneously.

It might seem that with this the ultimate goal of space telegraphy, leaving the question of distance out of consideration, had been reached; but Prof. Slaby was not satisfied to stop at this point, and with scientific zeal he and his assistant, Count Arco, have devised various improvements which can only receive the barest mention here.

The effects at the receiving apparatus are still further strengthened by inserting a properly tuned induction coil between the free end of the extension wire and the coherer. The coil, which Prof. Slaby calls a "multiplier," acts like a resonator, absorbing the oscillations on the receiving wire and giving them out again at a higher potential, thus producing a more powerful effect on the coherer.

Finally it has been found possible to dispense altogether with earth connections at the receiving wire by an arrangement which in its latest and simplest form is due to a happy inspiration of Count Arco.

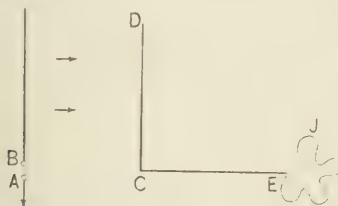


FIG. 4.

DCE is the receiving wire already described, equal to half a wave-length. If, now, there be added at the end of E another wire EJ, also equal to half a wave-length, there will exist between E and J a difference of potential twice as great as between E and earth, and if the coherer be placed between E and J the effects upon it are doubly intense.

Experiments are to be made with German naval vessels in order to determine the maximum distance at which signalling with this improved apparatus is possible.

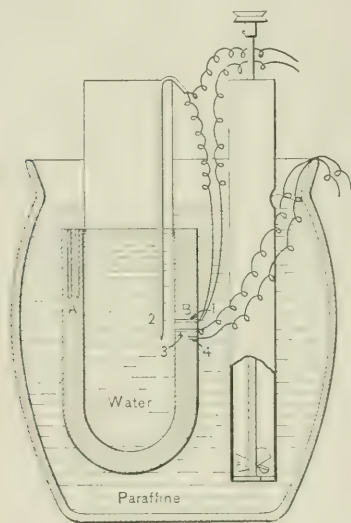
The Transmission of Heat Through Metals.

ONE of the elements in boiler design about which there has been but little definite information up to the present time, is the question of the transmission of the heat from the fire on one side to the water on the other. With this is also to be considered the very important matter of the relative temperatures of the two sides of the metal plate with regard to the extent to which the water protects the metal from the injurious and weakening action of the heat. Increasing pressures and dimensions have made it most desirable to employ thicker plates in boiler construction, and in the United States one of the large steam boiler insurance companies has announced the willingness of its engineer to accept greater thicknesses of metal exposed to fire than have hitherto been thought advisable. For this reason the investigations which have been carried on at the Physikalisch-Technischen Reichsanstalt upon the transmission of heat through metal plates, conducted by Messrs. Holborn and Dittenberger, and published in the *Zeitschrift des Vereines Deutscher Ingenieure* are of much interest, and furnish fuller data than were previously available.

The early researches of Pécelet, upon which the general ideas of engineers are based, assumed that the transmission of heat depended upon the conductivity of the metal, but practical experience in steam heating has proved that the rate of transmission of heat depends to a very great extent upon the motion of the fluids in contact with the metal, this introducing into the problem an element very difficult of measurement.

In the experiments made at the Reichsanstalt it was attempted to make the results comparable by maintaining the same circulation in all cases, so that the disturbing element should be removed, rather than determined. Briefly, the apparatus consisted of a vessel of brass with comparatively thick walls, the metal being 2 centimetres thick, this containing water and being immersed in a larger vessel containing paraffin, palm-oil, or other substance having a comparatively high boiling point. In the outer vessel was also placed a tube open at the bottom and the surface of the liquid, and containing a small propeller, revolved by an

electric motor. For a constant speed of the propeller the circulation was maintained at a practically uniform rate during any series of experiments. In the walls of the inner vessel were imbedded thermoelectric elements, placed at different depths, both radially and longitudinally, and by these means the relative temperatures of the metal at different points were determined. The whole arrangement is clearly shown in the illustration. At 2, there was introduced a thermoelement in a glass tube immersed in



the water close to the point where the measurements in the metal were taken, and so all the elements for determining the rate of transmission of heat through the walls were given.

The results of several series of measurements are given in the paper, tabulated in a form convenient for comparison, and by the method of least squares the coefficients for the formulas of the authors were deduced. Although these formulas were deduced for the particular brass employed in the experiments, the constants can readily be modified for any other material of which the conductivity is known, and the coefficients for iron are given in the article. These formulas enable the computation of the number of heat units transmitted per square metre of heating surface per hour for a given difference of temperature, the whole forming a valuable contribution to an important branch of applied science.

The Regulation of Steam Engines.

ONE of the marked improvements which has been made in modern steam engines is the closer regulation obtained, and this is in response to a well understood demand. The closeness of governing, however, is not altogether dependent upon the governor itself, as a governor may do well upon one type of engine and not so well on another.

The subject of the relation of the engine itself to the method of governing and form of governor forms the matter of a paper by M. Delaporte, published in a recent issue of the *Revue de Mécanique*, and although the treatment is too mathematical for full discussion in these columns, the general line of reasoning may be outlined.

M. Delaporte, for the sake of simplicity, assumes a governor of a type well known, in which the centrifugal force of a revolving mass is opposed by the tension of a spring, and also assumes that the friction is negligible and that the valve is exactly balanced.

The admission of steam into the cylinder of an engine is discontinuous, but with high-speed engines the oscillations in the governor are much longer in duration than the time of a single stroke of the engine. It is therefore assumed that the flow of steam from the chest into the cylinder may be considered as practically continuous. Since the mean exhaust pressure, whether into a condenser or against the atmosphere, is lower than 0.57 of the pressure in the steam chest, we may, according to Napier's law, consider that the flow is directly proportional to the density of the steam and to the size of the opening.

Taking these premises it appears that the size of the steam chest, *i. e.*, the volume of steam between the governor valve and the cylinder, exerts an important influence upon the regulation, the exact relation being expressed mathematically in a formula including the pressure in the steam chest. The closest regulation is secured by having the smallest practicable space in the valve chest, but this naturally affects the initial pressure in the cylinder, and requires a somewhat larger cylinder to produce the same power.

The weight of the fly wheel also enters into the solution of the problem, and in general terms, for a given engine, with a determined volume of steam chest, the weight

of the fly wheel should increase in proportion to the increase in steam pressure, a fact which is confirmed by experience as well as theory. With a governor of the type under consideration, having a revolving mass opposed by a spring, isochronism and stability cannot be attained together, since the equations show that for such a result the weight of the fly wheel should be infinitely great.

It is impossible to follow the analysis of this interesting paper without going too extensively into the mathematical discussion, but it touches a field in steam engineering but little worked.

The Commercial Influence of the Siberian Railway.

MUCH has been said and written about the Siberian railway from the point of view of construction, but as the work upon this great undertaking approaches its completion, its commercial and industrial significance looms up as a subject of vast interest, not only to the engineer, but also to the manufacturer and business man. In fact, the work of the engineer is becoming so closely bound up with industrial and commercial interests that it is neither possible nor desirable that they should be considered other than together.

For these reason the papers of M. de Krivochapkin upon the economic influence of the Transsiberian railway upon the mineral industry of Siberia and upon international commerce, published in recent issues of *Le Génie Civil*, merit extended review and discussion.

Although Siberia has formed a part of the Russian empire since the close of the sixteenth century, the entire control of the country to the Pacific coast was not completed until 1860, when the treaty of Peking recognised authoritatively the Russian possession of the entire Amoor region, and thus opened the way to the sea of Japan. About the same time the abolition of serfdom in Russia caused a strong tide of emigration towards Siberia, this being wisely encouraged by the emperor Alexander II. as the best means of advancing the value of the Asiatic portion of the empire. It was only in 1891, however, after the travels of the Hereditary Grand Duke Nicholas, now Nicholas II., to the Far East, that the ex-

ecution of the great projects for the development of Siberia were actually begun.

As has already been described at various times in these columns, the Transsiberian railway, begun in 1891 at Vladivostok, on the Pacific, and in 1892 at Tcheliabinsk, on the European frontier, is divided into six great divisions:

1. The Western Railway of Siberia, from Tcheliabinsk to Obe, 880 miles.
2. The Central Railway of Siberia, from Obe to Irkutsk, 1,137 miles.
3. The Circum-Baikalien Railway, skirting around Lake Baikal, from Irkutsk to Missouaia, 686 miles.
5. The Railway of the Amoor, from Streliensk to Khabarovsk, 1,380 miles.
6. The Oussouri Railway, from Khabarovsk to Vladivostok, 475 miles.

The Circum-Baikalien Railway is not yet in operation, being at present replaced by the railway ferry across Lake Baikal, while the railway of the Amoor has been abandoned in favour of the later route through Manchuria, all the other sections being now in actual operation.

In the place of the railway along the valley of the Amoor there has been substituted the Eastern Railway of China, this reducing the total distance from Tcheliabinsk to Vladivostok to 3,967 miles, and from Tcheliabinsk to Port Arthur to 4,242 miles.

M. de Krivochapkin discusses both the constructive features of the railway and the resources of the various sections, but as the former have already been recently examined in detail in these columns, we shall review mainly the latter points.

The western railway of Siberia traverses mainly an agricultural country, already well developed both as a grain-raising district and a region of grazing and the breeding of horses and cattle. Although there are as yet no mineral undertakings developed in this country, it is believed that deposits of gold, copper, argentiferous lead, and petroleum exist in the Altai mountains, and that the proximity of the railway will accelerate their development. In 1898 the western railway of Siberia carried to Europe 280,407 tons of cereals and 112,713 tons of general merchandise, and from 1896 to 1898 there was an immigration of 280,000 persons to this section. Each male emigrant is given 40 acres of government land, with an ex-

emption of three years from taxation, and a further exemption of three years immediately following the return from military service.

The central railway of Siberia traverses an altogether different kind of country, mountainous and heavily wooded. This section of the railway crosses the Yenesei river at Krasnoiarsk, there being steamers of light draught navigating the river at this point and connecting with the deep-water navigation of the Yenesei starting at Yeneseisk and reaching to the Arctic ocean. This section of the railway traverses the mineral portion *par excellence* of Siberia. Here, in the Government of Tomsk, lies the portion of the Altai mountains known to the Chinese as the Gold Mountains, with a mean altitude of 5,000 feet above sea level, the highest peak being Bieloukha, 11,650 feet high. Here also is the great Katounsk glacier, nearly eight miles in length. The gold of the district is found in an auriferous quartz and also in the placers of the districts of Mariinsk, Kousnetsk, Biisk, and Barnaulsk; the last official report showing an annual production of 3,423.420 kilogrammes of gold. There are 124 placers in the Altai region, the sand containing 0.540 grammes to 0.800 grammes of gold to the metric ton (about 0.019 oz. to 0.028 oz. to the ton). There are also 800 mines of silver, copper, and lead in the Altai district, and in various parts of the Government of Tomsk are extensive deposits of iron, coal, and salt. There are quarries of marble, and other valuable stone at Biisk, and jasper, porphyry, and agate are freely found. In the western part of the section traversed by the central railway of Siberia, in the Government of Yeneseisk, gold is extensively found, being distributed generally over the whole of this immense area and concentrated in the valleys and along the watercourses. The exploitation of the Yenesei region began in 1839, since which time there has been produced 442,260 kilogrammes of gold. The greatest production was between 1839 and 1850, when it reached 16,500 kilogrammes per year, in spite of the most rudimentary methods of washing; and at the present time it is found profitable to rework the tailings left as valueless at that early date. Most of these deposits are placers originally beneath several feet of earth, and in most

cases the workings are open to the surface, or in some cases are in galleries or tunnels beneath to perpetually frozen ground.

Silver and copper are frequently found in the Yenesei valley, the silver occurring in the form of an argentiferous galenite, mingled with copper pyrites. There are also extensive deposits of iron in the form of magnetite, as well as coal and graphite; the extensive deposits of graphite at the Alibert mines are in the Government of Irkoutsk, and have been worked for a long time.

The region of the railway in the neighbourhood of Lake Baikal has been fully discussed in these columns last month, with especial reference to the heavy ice-breaking ferry boats used pending the completion of the Circum-Baikalien railway. This portion of the country has been as yet but little explored, but there is every reason to believe that it will be found rich in mineral resources. Petroleum has already been found in the vicinity, and the geological character of the country is similar to the auriferous localities already worked.

Beyond the Baikal region the mineral riches of Siberia are remarkable. Iron, in the form of magnetite is abundant, and coal has been already found in twenty different localities. The gold placers of the district, mainly government property, have been worked for nearly a century, the output of the imperial mines now being 3,734,640 kilogrammes per year, and increasing, while there are 206 private claims being worked. Silver, lead, and copper are also found, and here the only deposits of tin in the Russian empire.

The Ossouri railway, extending northward from Vladivostok to Khabarovsk was originally intended to form the connection to the Amoor branch of the main line, and was the first section constructed; but with the abandonment of the Amoor division in favour of the Eastern Railway of China, as the Manchuria section is called, the Ossouri railway has become practically a separate road connecting the Amoor with the Pacific seaport.

In conclusion the following summary may be given:

In the nine years from 1891 to 1900 the administration of the Transsiberian Railway, composed entirely of Russians, and using Russian material, has constructed 3,354

miles of railway, or about 375 miles per year. The cost of this great work has been more than 1,000 million francs. No other railway of such importance has been so rapidly built; the nearest approach being the Canadian Pacific Railway, about 2,900 miles long, having been built in ten years.

It is impossible to enlarge upon the manifold consequences which must follow the opening up of this wonderful region to the commerce of the world. Not only must there follow a marvellous extension of the mineral development of the regions here briefly mentioned, but all the great industrial and commercial results of the influx of immigration into a vast agricultural country will surely come.

The Evolution of Science.

In pronouncing his annual address as retiring president of the Académie des Sciences, M. Maurice Levy gave a remarkable review of the evolution of science during the only century in which scientific thought and work have dominated the progress of civilisation. The address is given in full in the *Comptes Rendus* of the Academy, but abstracts of certain portions will be appropriate in this place.

Starting with the admitted fact that practice in nearly every instance has preceded theory, and that theory has then enabled practice to advance to further improvements, M. Levy rapidly reviews the history of science in previous centuries in order to discover why the evolution of science has progressed but slowly until recent times. Nearly all the fundamental phenomena of the various branches of science have been observed during many centuries, and only after long lapse of time have these principles been developed and applied with that system and judgment which may truly be called scientific.

Thus, for example, the attraction of the lodestone for iron and steel was known for ages, but it was not until the expansion of navigation in the fifteenth century that the compass came into use. The philosophers of Alexandria were familiar with the force imparted by heat to vapour of water, but it was not really until the commencement of the nineteenth century, after the expiration of the patents of Watt, that the development of the steam engine really began, and

not until the formulation of the science of thermodynamics in the latter half of the century, that the improvements were made which enabled a horse power to be obtained with one-fourth to one-fifth of the fuel consumption formerly necessary. In this connection M. Levy calls attention to the remarkable prediction of Oliver Evans concerning, not only the development of the locomotive engine, but also of the automobile, the latter prediction requiring practically the entire century for its accomplishment, although all the data for its full realisation were in existence in Evans's own time.

A number of such examples might be given, but the facts are sufficiently well known, and hence M. Levy passes to the query as to why the systematic evolution of science and scientific methods have been almost entirely reserved to the century just closed. The answer he finds in the liberation of thought, by which alone it was made possible for the phenomena of nature to be studied intelligently, without the trammels of preconceived and erroneous notions.

Starting with the great work of Newton, and following with that of Laplace, d'Alembert, Lagrange, and Lavoisier, the field was prepared for the application, in the nineteenth century, of scientific methods to the study of observed facts. In this work the position of pure science, so-called, must not be overlooked. What in one age appears almost a vain speculation, without practical application, becomes in a succeeding period a vital factor in material progress. We must not forget that if applied mechanics to-day enables us to compute and determine in advance the strength and motion of the organs of the most complex machines, it is because in former ages the shepherds of Chaldea and Judea observed the stars; because Hipparchus collected their observations with his own and transmitted them to succeeding generations; because Tycho-Brahe continued and perfected them; because, two thousand years before, Apollonius of Perga produced a treatise on conic sections, regarded as useless by many following generations; because the genius of Kepler, uniting the work of Apollonius with the observations of Tycho-Brahe, gave us the sublime laws which bear his name, although deemed useless by the practical men

of his day; and finally, because, from all this pure scientific work of his predecessors, Newton deduced the law of universal gravitation.

The share of France in the evolution of science in the nineteenth century has not been small, and M. Levy enumerates a list of notable names in various departments of work. Thus we find that Navier, Cauchy, Poisson, Lamé, and de Saint-Venant created or perfected the science of molecular mechanics. Navier, Clapeyron, Bélanger, and Bresse advanced the knowledge of the resistance of materials. Poncelet, by the publication of the "Leçons de l'Ecole de Metz," created the science of industrial mechanics subsequently developed by Coriolis, Bélanger, Résal, Phillips, and others. Borda, Dupin, and Reech perfected the art of navigation and the theory of ships, while Poinot threw a brilliant light upon the whole range of mechanics by the introduction of the notion of couples.

Thus, from the untrammelled application of scientific thought to observed facts, all has been resolved into matter and motion. Heat is motion, light is motion, as is also electricity; and all special theories of peculiar fluids, special forms of matter, etc., have been abandoned. Whatever may be the revelations of the near future, the great doctrines of the nineteenth century will long remain at the foundation of all science and of all human industry. By their generality, by their strength, and by their simplicity, they offer the widest and most secure base for a structure which may lead to developments which, while not to be predicted with certainty may at least be indicated in character.

The Influence of Heat on the Strength of Bronze.

THE increasing use of high steam pressures and the applications of superheated steam render it most desirable, that fuller knowledge should be had as to the effect of heat upon the strength of the materials used in steam connections, especially such copper alloys as are so generally employed for pipes, valves, valve-chests, etc. An extensive series of experiments have been made by Professor Bach upon the behaviour of bronze under high pressure steam and from his paper in the *Zeitschrift des Vereines des*

Deutscher Ingenieure a brief account of the experiments and the most important conclusions may be taken.

The experiments of Professor Bach were made upon the standard bronze used in the government shipyard at Kiel, the composition being, in percentages, copper 91, zinc 4, tin 5. A number of test pieces of this bronze were tested at atmospheric temperature, about 20° C. or 68° F., showing an ultimate resistance of 36,000 pounds per square inch, with an extension of 36.7 per cent., and a reduction in sectional area of 47.4 per cent. Tests were then made upon similar pieces at temperatures from 100° C. to 500° C., advancing 100° with each set of four tests, the results being tabulated and plotted as curves.

Without going fully into the details of the tests, for which the paper of Professor Bach must be consulted, the following results are given:

	100°	200°	300°	400°	500°
K	34,500	30,200	19,450	8,900	6,280
p	35.4	34.7	11.5	0	0
q	47.4	48.2	16.2	0	0

In which K is the ultimate strength in pounds per square inch, p the percentage of elongation, and q the reduction of cross section.

According to these results it is evident that a bronze of this composition should not be used for pipes, valve chests, etc., in which the temperature of the steam exceeds 200° C., corresponding to a pressure of about 300 pounds pressure per square inch absolute, and that in no case should temperatures of 300° C. be reached.

Although the investigations of Professor Bach have thus far been confined to the bronze of the composition above noted, yet it is probable that nearly all copper alloys are similarly affected, although the rate of diminution in strength probably varies somewhat with the composition. It is therefore advisable, in designing machinery for use with high-pressure or superheated steam, that the material to be used should be tested under temperatures somewhat exceeding those which are to be attained in practice, and the behaviour noted, and it is altogether possible that some apparently mysterious fractures have been due to the unsuspected weakening influence of heat.



REVIEW OF THE AMERICAN PRESS

Electric Traction for Heavy Service.

ELECTRIC traction is making strong headway, for consideration at least, in connection with heavy service and main-line conditions, and one of the strongest presentations which has yet been made of the case for electric traction is the paper of Mr. Edward P. Burch presented before the Northwest Railway Club.

After reviewing the development of electric traction for city and suburban purposes, as well as the special service of the intramural railway at the World's Fair at Chicago in 1893, and later installations, Mr. Burch proceeds to examine the growth of material for heavy service. Without going too fully into questions of construction he gives the examples of what has been done in shifting and tunnel engines as sufficient evidence of the capabilities of the electric locomotive.

"In 1895, the Baltimore & Ohio R. R. put in service three heavy electric locomotives for hauling standard passenger and freight trains through the B. & O. tunnel under Baltimore. Each locomotive weighs 194,000 lbs., all on the drivers. They are rated 1,500 h. p. each. A draw bar pull of 60,000 lbs. is easily obtained, and trains weighing 1,900 tons have been hauled up the 42-ft. grade at 12 miles per hour. Ordinarily each locomotive hauls 1,400 tons on the level at 15 miles per hour. Faster work can be done with these locomotives than with the steam locomotives. The management states that they thus save in the track required. They are handier, accelerate rapidly, yet are much less liable to break a train in two in starting. The advisability of extending the use of the electric locomotive on an 80-mile division of the road is now under consideration. In 1896, two 660-h. p. electric locomotives having 136,000 lbs. on the drivers, were installed on the Buffalo & Lockport Railway for switching purposes over the tracks of the Erie R. R. Twenty loaded cars are commonly hauled.

"Since these early installations, hundreds of heavy electric switching locomotives have been purchased for use in railroad yards, terminal railways, belt lines, at factories, steel mills, etc. Two hundred electric mining locomotives have been sold by one manufacturing company within two years. Great advance may be expected from the consolidation of interests of one of the steam locomotive builders with a leading electric manufacturing company.

"It is thus evident that conservative railroad managers, who are convinced of the advantages of electric traction as a matter of commercial economy, will now have plenty of precedent for their guidance."

Coming now to other questions than those of the capability of the electrical engineer to provide the motive power, Mr. Burch proceeds to dispose of some of the objections which have been made.

"Electric traction applied to steam railroads will or should mean very few radical changes. Consider the adoption of electric power on some railroad having, say, five or more trains in each direction daily, for example, on any road radiating from the Twin Cities, to Fargo, to Duluth, the Soo, to Chicago, or to Omaha. The water tanks, with their coal depots and usual attendants, machinery, trestle work and buildings, will be consolidated in a few advantageously located central power stations. The locomotive tender, with its coal and water load, its repairs and depreciation, will be absent, and power will not be necessary for its propulsion. All the locomotive boilers and engine cylinders, the piping and accessories will be exchanged for a few large and economical steam producers and prime movers. Fewer locomotives will be necessary, as each will be capable of higher speed and greater annual mileage, a smaller proportion also being in the shops. Some of the locomotive firemen may be utilized in the power stations. The steam locomotive is short-lived and is either rebuilt, worn out

or a drag on the service after 10 years' work. The mechanical superintendent need not worry about a larger scrap pile. Ordinarily the steam locomotives will be used up, on divisions not equipped for electric traction, or sold. The heavy electric locomotive will simply be substituted for its steam rival. The balanced working parts, general simplicity and ease of control will commend it. In addition to the substitution noted above, which will save an immense amount in depreciation, heavy additional investment will be necessary for metallic conductors to transmit the electrical energy; transformers (located at ticket stations), and working conductors for the electric motors."

From the operating standpoint the advantage lies with electric traction. Taking the reports of the Inter-State Commerce Commission, it appears that the repairs of engines and roadbed, water supply, wages of engine and roundhouse men, and fuel, make up 36.7 per cent. of the total operating expenses of railways. Examining these items for electric traction it appears that marked savings can be made in all of them. Besides this, the steam locomotive has already reached the limit of capacity in certain directions, while the demand for increase remains unsatisfied. This is especially the case with regard to the boiler, which the limit of gauge prevents being made larger.

"The gauge does not limit the design and the capacity of the motors in electric locomotives. The steam locomotive has its source of power upon its back. The electric locomotive has the entire power station behind it. In steam locomotives, the moving parts reciprocate, and thus the speed of passenger trains is limited. The moving parts of a motor rotate. Likewise, the backbone of railroad business, the freight traffic, now calls for heavier trains and much faster schedules. Railway managers demand this. Expenses are per train-mile and the revenue per ton-mile. How is this demand to be met if the limit has already been reached in the capacity of steam locomotives?"

In the opinion of Mr. Burch the whole question really hinges upon the advisability of incurring the heavy investment for additional equipment. This, however, may

not be one which can be evaded. The progress of invention and industry has never been successfully opposed by existing interests, however much it may have been retarded. Old ideas are constantly being replaced by new, and the mistaken conservatism which endeavors to place itself in a false position must inevitably be compelled to recede.

"In the application of electric traction to heavy railway service, the steam railway engineer and the electric railway engineer must work together. Their first work is to get the facts as they exist—to get the actual power required for all classes of service, switching, freight and passenger. The facts regarding average and maximum service require the best judgment. Each possible saving must be detailed, as outlined; in repairs of roadway, repairs and renewals and supplies for locomotives, in wages of engineers, firemen and helpers, and in the shops, in fuel and in many other items which at once suggest themselves. Contrariwise, there will be the interest, depreciation and maintenance of additional equipment, central-power stations with either steam prime movers and boilers (or a dam and turbine), electric generators, transmission lines, transformers and alternating current distribution. Electric traction is clearly an important development in railway engineering, nothing radical being proposed. Its adoption is never warranted, except on a basis of increased economy of operation. The supersession of the steam locomotive by the electric locomotive is primarily a question of profit and loss, and here the proposition stands in favorable light for commercial consideration."

Judgment in Technical Matters.

The education of the judgment is very properly regarded as very important in all branches of thought and work, and in none is it more valuable than in the work of the engineer. For this reason the thoughtful and original paper of Mr. George W. Dickie, recently presented before the Technical Society of the Pacific Coast, and published in the *Journal* of the Association of Engineering Societies, is of much interest.

Mr. Dickie shows the impossibility of teaching "common sense" in educational in-

stitutions because of the impossibility of finding suitable professors, and is obliged to admit that each individual must acquire this most important portion of his training by practical experience, and with but moderate success in most instances.

The tendency to self-deception is very strong in all men, while at the same time the bias which appears in individual judgments is for the most part honest and unconscious. As a result, there appears to be growing up a system which apparently proposes to dispense with the necessity for the exercise of judgment in dealing with everyday problems in engineering. Young men without experience, who have never had the chance to acquire an educated judgment, are often put in charge of important work, and a set of instructions provided for their guidance, which instructions are supposed, if rightly carried out, to obviate the necessity for any exercise of judgment on the part of the person in charge.

This is especially the case with inspectors appointed to examine work executed by private firms for government and other contracts, and the results in many cases are interesting and peculiar. Instructions, often framed by persons by no means competent to take charge of the work themselves, are required to be followed in an implicit and unreasoning manner by inspectors who, not having proper judgment themselves, are thus prevented from considering the judgment of those who are competent. The general idea is that instructions of this sort are intended to protect the government or other party for whom the work is being done. As a matter of fact there are two parties to every contract, and both are equally entitled to protection, while the real purpose of the instructions should be the production of the best possible piece of work.

Mr. Dickie gives a number of interesting examples of the manner in which test requirements and similar conditions have been enforced to the positive detriment of the product. Thus a welded joint in a boiler was rejected because the metal was one thirty-second of an inch thinner at the seam than required by the specifications, and a riveted joint demanded instead, thus permitting a seam of 67 per cent. of the

strength of the plate to be used, and rejecting one giving 92 per cent. The welded work was condemned and thrown away not because of any desire on the part of the inspector or his superior to cause loss to the contractor, but simply from a failure on their part to apply sound judgment to the question.

"A plan or specification is an instrument to be used for the production of a certain piece of engineering work. The thing produced is the only reason for the instrument being brought into existence, and when once the instrument has served its purpose its value disappears.

"Yet engineers engaged to apply this instrument are, as a rule (especially the young men), more intent on applying the instrument than in considering what the instrument may be doing, forgetting that the instrument can of itself produce nothing, and that if not applied with judgment it will produce only such things as the man that made the instrument could himself produce. But, when applied with the correcting power of sound judgment, acquired in the production of similar things with other instruments, it becomes pliable in the hand of a master, and the result is the combined power of the instrument with the trained judgment of him that applies it.

"All technical men engaged in producing tangible things out of ideas expressed in our defective language, interpreted by some one perhaps better acquainted with words than with things, and whose judgment has not been matured by any intimate knowledge of the actual work that the specification he is to enforce is intended to produce, feel how hard it is to get their position understood, and how often they must do things against their better judgment for fear it may be thought that their own interest, and not their experience, is the foundation on which their judgment rests."

The Exhaustion of Nature's Stores.

A RECENT editorial in *Engineering News* sounds the alarm concerning the reckless manner in which mankind is wasting the stores of energy provided by nature, and properly claims that the task before the engineer in the twentieth century is that of facing and solving this great problem. This is considered to be more especially

the case because the past century has been the one in which the reckless use of nature's stores really began.

"When future generations look back upon the nineteenth century, whose work we now regard with such pride, it is quite possible that their chief sensation will be wonder at the profligate waste that characterized the people who first made large use of the earth's stored-up riches.

"We shall not be far from the truth if we say that, until the nineteenth century, mankind was content to live off the annual produce of the earth. A trifling use was made, indeed, of the fuels and metals and minerals stored beneath the soil, but it was a mere nothing compared with the drafts which the closing years of the nineteenth century have made. A moment's thought will show the truth of this statement. Take our most used mineral, coal. When the nineteenth century began, the railways and steamships, which now make such enormous drafts on the world's coal seams, were undreamed of. The stationary steam engine had had its beginning, but its use was still so limited that it cut no figure at all in the world's coal consumption. The principal use of coal was for household fires and for the crude metallurgy of the day, and this only in countries like England, where the removal of the forest growth had caused a scarcity of wood and of its product, charcoal.

"With no railways, no steamships, no factories and mills, the consumption of metals was almost as trifling as that of coal. Not until the nineteenth century, and indeed not until the last two-thirds of that century, did mankind begin to make any appreciable drafts upon the treasures laid up in nature's storehouses.

"For the last 50 or 75 years, however, the use of these stored materials has been prodigious. Each year sees an increase in the consumption of all the things which the earth yields; and we are accustomed to point to this growth as evidence of the world's advancement in civilization. Is it not time to ask ourselves whither all this is tending?"

Assuming that the demand for energy in some form is bound to increase in an accelerated ratio during the century just begun, it is worth while to discuss the prac-

tical means by which not only current demands may be met, but future sources indicated, and this is indeed the work of the engineer in the broadest sense of the term. Taking up the various requirements of mankind in turn, the article referred to proceeds to show how food supplies, structural materials, fuel supplies, precious metals, all are being exploited, not only to an enormous extent, but also in a most wasteful manner.

While this exhortation to greater economy and abstention from waste is timely and thoughtful, yet at the same time there are some points about it which will bear further study and thought.

Considering first of all the vital question of food supply, the doctrine of Malthus, concerning the rate at which population was overtaking subsistence, was first brought to public notice in 1798, and so brought that subject to attention at the beginning of the last century. The theory, as it was epigrammatically put at a much later date, consisted in the statement that "the world would some day wake up to find that the last possible breakfast had been eaten the day before."

As a matter of fact, certain laws have since been discovered which bear somewhat upon the subject. We now know that matter and energy are both indestructible, and that the elements of which subsistence is composed must always exist in undiminished quantity. That the slow processes of nature in the conversion of inorganic material into organic and sustaining compounds may not be equal to future demands may indeed be true, but it does not follow that food products may not hereafter be made in the laboratory on a huge commercial scale, at a rate commensurate with all requirements. Certain it is that the material for such synthetic technical chemistry cannot be lacking, and it is only the methods which need to be developed. If chemistry is to be held responsible for the restoration to the soil of the elements needed to maintain vegetation, why not go a step further, and conduct the entire work in the rapid laboratory rather than in the slow field? The exhaustion of fuel supply has already pointed out the necessity of utilizing other sources of energy for mechanical purposes. Of such sources there is no lack.

Already electrical transmission has caused a return to water power to become practically commercially possible. Add to this the utilization of solar heat, of the internal heat of the earth, and of the energy of the waves and tides, and we have sufficient for all future purposes; supplies not stored in the past and subject to exhaustion, but generated continually, or rather derived from that one great source, the sun. When that source begins to fail, the demand will fail with it, and human life will be exhausted long before its supply of solar energy is gone.

So far as the supply of materials of construction is concerned there is little need for alarm. The metals already extracted from the earth can be supplemented by other whose reduction has only become possible by recent methods. Aluminum will doubtless become of increasing utility as its production is facilitated, and the supply is practically unlimited. Artificial stone will replace the natural article and will possess the advantage of greater ease of preparation. Other artificial materials will doubtless be evolved to supply the demand, and as the absolute destruction of matter is impossible, so the supply of material for conversion remains constant, and only the method of conversion enters into the problem.

It is by no means intended that this view of the situation should weaken the warning conveyed in the article referred to, so far as urging the reduction of waste is concerned. One of the fundamental principles of good engineering is the prevention of waste. The term "by-product" has no real right to existence, as all products should be equally important and none should be permitted to go to waste. The development of processes of direct utilization of natural energy, and the synthetic production of substances now obtainable only through the slow processes of nature, must necessarily take time, and the transition must be gradual and tentative. The work of the engineer in the new century must be devoted both to the reduction of wastes in existing methods and to the production of new and better methods which shall be, so-to-speak, "endless chains," having for the basis of their action the fact that both matter and energy are indestructible, and that nothing is ever lost or useless.

Engineering and Architecture.

A RECENT editorial in the *Iron Age* calls attention to the manner in which the function of the architect is disappearing, as that of the engineer becomes more and more important, in the evolution of modern building. Formerly the architect made the entire designs, not only of the visible portions of a structure, but also of its constructive details, and in addition superintended its actual construction. With the recorded experience of ages at his disposal he was able to adapt or invent, as taste and circumstances demanded, and the experience of the builders who actually executed his work made matters comparatively simple.

To-day it is difficult to say wherein the true function of the architect in a modern building exists. The limitations of construction give little opportunity to exercise the artistic side of the work formerly so fully elaborated, while the construction must necessarily fall to the portion of specialists. Foundations require the most skillful work of the civil engineer. Structural work involves mechanical engineering in combination with a knowledge of manufacturing conditions. Elevators, lighting, etc., fall to the share of the electrical engineers, while a modern office building or hotel contains more of the work of the sanitary engineer than many a town fifty years ago.

At the present time the architect assumes the general direction of the whole work, while the actual planning and execution must be performed by specialists in each department of work, and as these departments are almost altogether engineering in their nature it seems not at all unlikely, as the *Iron Age* puts it, that the function of the architect may, before long, "be eliminated altogether by the engineer, who will assume the baton, and, when he needs him, employ an artist to design his ornamentation."

The Progress of Aluminum.

IN A review of the position of aluminum at the Paris Exposition of 1900 presented to the Franklin Institute by Professor Joseph W. Richards, and published in the *Journal* of the Institute, there is told a story of development in a branch of applied science almost without a parallel.

At the Paris Exposition of 1855 there was

shown a small bar, costing probably more than its weight in gold, and representing only a laboratory curiosity. By 1867, Deville had perfected the sodium process, and many exhibits of a practical character were seen. The production reached about one metric ton per year, and the cost was about \$12 a pound. But moderate progress appeared at the next Exposition in 1878. The price had not been reduced, and the applications were necessarily limited. In 1889, however, a revolution in the industry was apparent. The improvements of Castner and Netto in the manufacture of sodium at a greatly reduced cost, made a corresponding reduction possible in the cost of aluminum, the selling price falling to \$5 per pound, while the electric processes of Cowles and of Heroult enabled aluminum alloys to be produced at even lower prices.

"The last year of the century finds the industry upon an entirely different basis. From an annual production of 70 tons it has risen to the relatively enormous figure of 7,000 tons; from a price nearly \$5 a pound, to the almost incredible figure of 30 cents. The seeds of this revolution were already germinating in 1889, for in that year pure aluminum made electrolytically by Hall in America, and Heroult in Europe, began to undersell the product of the sodium processes, and two years later the sodium processes were distanced and driven out of the business. The pure aluminum shown in 1889 was all made by the sodium process; that shown this year was as exclusively electrolytically produced.

"It is almost needless to say that this decrease of price to less than one-tenth of its value in 1889 has been the prime cause of the great demand for the metal. Every decrease in price has opened up the way for larger and novel uses. Many an experimenter has reported of aluminum: 'It is most admirably adapted for this purpose, and *when its price shall have been reduced*, etc., etc.,' and has waked up a year or so later to the fact that his hoped-for reduction of price had occurred, and that the application he had discovered was then possible. The same is true now, as then; possible uses for large quantities of aluminum are now known, which the probable reduction in price during the next five or ten years will convert into actual uses.

"Such being the present facts with regard to output, prices and applications, we can state with exactness that the aluminum industry is now, at the end of the century, upon a strictly normal commercial basis. Aluminum is now as really a metal of every day life as silver, nickel, mercury, copper, brass, tin, zinc, lead or iron, though not to the same degree as several mentioned. In the United States, in 1898, only pig iron, copper, lead and zinc were produced in greater quantity than aluminum, and only pig iron, copper, lead, zinc, silver and gold surpassed it in value of output. Nickel, mercury, antimony, bismuth and tin were all surpassed. When we wish to make a given object in metal, it can be made cheaper in aluminum than in anything else, excepting zinc, lead or iron; brass, copper, and all the other metals are dearer."

The firms now producing aluminum are the Pittsburg Reduction Company, Niagara Falls; the Cowles Electric Smelting and Aluminum Company, Niagara Falls; the British Aluminum Company, at Foyers, Scotland; the Aluminium Industrie Actien Gesellschaft, at Neuhausen, Switzerland; the Société Electrometallurgique Française, at La Praz, Savoy; the Société Industrielle de l'Aluminium, at St. Michel, Savoy. This year will also see put into operation a new plant of the Pittsburg Reduction Company on the St. Lawrence River, Canada, and two new plants of the Neuhausen Company, one on the Rhine at Rheinfelden, Germany, the other at Lend-Gastein near Salzburg, in Austria. The establishments already in operation have capacity of 34,000 horse-power, capable of producing 7,000 tons of aluminum a year; with the additions referred to, the totals will be 47,000 horse-power, and 10,000 tons annual capacity.

Electricity on the Manhattan Elevated Railway.

A RECENT issue of the *Street Railway Journal* is devoted in great part to the plans and work for the conversion of the elevated railway system of New York from steam locomotive traction to electric power. The undertaking is so extensive, and this account is so exhaustive that little more can be done here than to call attention to the article and make some general comments.

The apparent tardiness of the administra-

tion in delaying the adoption of what seems the ideal motive power for such a road is explained by the wisdom which permitted other roads in other cities do the experimenting, and thus render it possible for New York to secure the best and latest equipment possible. Doubtless this was wise from one point of view, but this argument carried to its logical conclusion would, if applied throughout the United States, have caused electric traction to be as far behind there as it was a year or two ago in the rest of the world. However that may be, the work is now well advanced, and will doubtless be most successful, it being expected to have the engines turning in the power house by June 1, of the present year.

The magnitude of the undertaking will be realized when it is understood that the main power station is expected to be capable of generating 100,000 horse power, and this energy is to be distributed to 200 moving trains on the elevated railway with certainty and satisfaction. New York is dependent in great part upon this system of lines for the transportation of the greater part of its active population in the course of daily work and any interruption of the service would entail a loss of time amounting to a great public disaster. An example of what the problem involves is found in the figures given below. Thus, on one day in 1899, the Sixth and Ninth Avenue divisions alone carried 490,000 passengers, while on two consecutive days last year all of the lines carried 1,700,000 passengers. During the heaviest period of traffic, 140 trains, or 640 cars, per hour, were run on the western division, and 280 trains, or 1,280, on the entire system. The grand total for the twenty-four hours was 4,828 trains, which made 43,853 train miles, and 21,984 cars, which made 198,399 car miles. The record traffic figure of the system for twenty-four hours was made in 1892, when 1,075,000 passengers were carried in one day. In the entire history of the railway company, during which it has carried over three and a third billion passengers, it has never killed a passenger in an accident to a train. In view of the excellent management, by which these results have been secured with steam locomotives, it is not too much to expect that with far better electric equipment, the traffic of the company will increase in a

manner which will make the present figures seem insignificant.

The completion of the conversion of this remarkable service from steam to electric traction will form undoubtedly the greatest electric and power installation, with the exception of Niagara, yet attempted, and the detailed account as given in the collection of articles above referred to is a most complete story of a great engineering feat.

Moulding by Machinery.

THE introduction of machine moulding is a matter under consideration in many foundries on both sides of the Atlantic at the present time, and hence the paper recently read before the Foundrymen's Association by Mr. I. L. McCord and published in the *Foundry* is very timely.

The work of moulding may be analyzed into five principal operations, viz.:

1. Getting the flask, pattern and match board together and putting in the sand.
2. Ramming or compressing the sand.
3. Removing the pattern from the sand.
4. Placing the mould on the floor.
5. Pouring the melted iron into the moulds.

Of course in addition to these five operations is the riddling of sand, the application of facing to the moulds, shaking out, etc., which for the present we will assume to be practically the same, whether the moulds are made by hand or on machine.

It is principally for the purpose of reducing the cost of the five operations mentioned that moulding machines have been invented, and it is obvious that the machine which will effect the greatest saving in the aggregate during these entire five operations is the most desirable machine, quality of work, of course, duly considered.

It is a comparatively easy problem to devise a machine which will effect a saving in one or two of these five operations. For example, on certain classes of light work patterns may be attached to metal match plates, so that they are at all times together in convenient form to set into the flasks, which may be stacked near at hand, and thus effect a saving in the first operation. Again, a machine can be readily constructed so that, regardless of the other operations, it will effect a saving in the second operation, that of

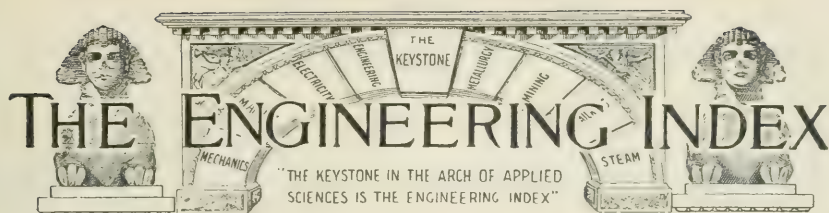
ramming the sand. Likewise stripping plates facilitate the removal of the patterns from the sand. The moulds may also be conveyed in some manner direct from the moulder to the cupola for pouring, and a saving thus effected in operations four and five. But to effect a saving at one point without increasing the cost at some other point is the perplexing question.

Many makers of moulding machines believe that the greatest saving can be effected by ramming the sand automatically and rearranging the remaining operations to accommodate a machine for power ramming. Where the ramming is the principal part of the work this position is doubtless correct, but there are other considerations. Mr. McCord gives many instances of the advantages of the stripping plate machines, showing that very often a greater output, all things being considered, can be attained by the use of simple hand-ramming stripping-plate machines, taking into account the extra handling of sand and flasks.

In discussing the general advantages of moulding machines, Mr. McCord concludes as follows:

"There are many questions that have been discussed in connection with moulding machines, such as the division of labor—that is,

having one force of men operate the machine all day, and another gang do the pouring. We believe these are matters that can best be adjusted by foundries individually. In many instances it is no doubt more economical to have a separate gang of men for pouring. In most cases, however, where you are trying to get along with laborers for moulding, we think it a good plan to have them pour their own work. There are not so many men to educate, and besides the relief from the monotony of moulding on the machine is a good thing for the men. They will feel themselves capable of doing more than one thing and will take more interest in their work. The fact that they may sit around a few minutes after the blast goes on is not going to count against them. They will not do one whit more work in a day without that little rest than with it. There are some progressive factories in other lines of business that give their employees 15 minutes' recess both in the forenoon and the afternoon, which takes a half hour out of their working day, but they consider it a good investment. And I do not believe any foundry will lose money by allowing their moulders a short 'breathing spell' from the time the blast is put on until they get their iron."



The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language*; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of \$1.00; G, of \$1.20; and H, of \$1.60. In ordering, care should be taken to give the *number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for \$2.00, thirty-three for \$5, and one hundred for \$15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or \$1.00 a year; to non-subscribers, 25 cts. per month, or \$3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: *Ill*—Illustrated; *W*—Words; *Anon*—Anonymous.

American Architect. *w*. Boston, U. S. A.
 American Electrician. *m*. New York.
 Am. Engineer and Railroad Journal. *m*. New York.
 American Gas Light Journal. *w*. New York.
 American Geologist. *m*. Minneapolis, U. S. A.
 American JI. of Science. *m*. New Haven, U. S. A.
 American Machinist. *w*. New York.
 Am. Manufacturer and Iron World. *w*. Pittsburg, U. S. A.
 American Shipbuilder. *w*. New York.
 Annales des Pontes et Chaussées. *m*. Paris.
 Architect. *w*. London.
 Architectural Record. *qr*. New York.
 Architectural Review. *s-q*. Boston, U. S. A.
 Architect's and Builder's Magazine. *m*. New York.
 Australia: Mining Standard. *w*. Sydney.

Automobile Magazine. *m*. New York.
 Automotor & Horseless Vehicle JI. *m*. London.
 Brick Builder. *m*. Boston, U. S. A.
 British Architect. *w*. London.
 Brit. Columbia Mining Rec. *m*. Victoria, B. C.
 Builder. *w*. London.
 Bulletin Am. Iron and Steel Asso. *w*. Philadelphia, U. S. A.
 Bulletin de la Société d'Encouragement. *m*. Paris.
 Bulletin of Dept. of Labor. *b-m*. Washington.
 Bulletin of the Univ. of Wisconsin, Madison, U. S. A.
 Bull. Int. Railway Congress. Brussels.
 California Architect. *m*. San Francisco, U. S. A.
 Canadian Architect. *m*. Toronto.

- Canadian Electrical News. *m.* Toronto.
 Canadian Engineer. *m.* Montreal.
 Canadian Mining Review. *m.* Ottawa.
 Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
 Colliery Guardian. *w.* London.
 Compressed Air. *m.* New York.
 Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
 Consular Reports. *m.* Washington.
 Contemporary Review. *m.* London.
 Deutsche Bauzeitung. *b-w.* Berlin.
 Domestic Engineering. *m.* Chicago.
 Eclairage Electrique. *w.* Paris.
 Electrical Engineer. *w.* London.
 Electrical Review. *w.* London.
 Electrical Review. *w.* New York.
 Electrical World and Engineer. *w.* New York.
 Electrician. *w.* London.
 Electricien. *w.* Paris.
 Electricity. *w.* London.
 Electricity. *w.* New York.
 Elektrizität. *b-w.* Leipzig.
 Elektrochemische Zeitschrift. *m.* Berlin.
 Elektrotechnische Zeitschrift. *w.* Berlin.
 Elettricita. *w.* Milan.
 Engineer. *w.* London.
 Engineer. *s-m.* Cleveland, U. S. A.
 Engineers' Gazette. *m.* London.
 Engineering. *w.* London.
 Engineering and Mining Journal. *w.* New York.
 Engineering Magazine. *m.* New York & London.
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
 Fire and Water. *w.* New York.
 Foundry. *m.* Detroit.
 Gas Engineers' Mag. *m.* Birmingham.
 Gas World. *w.* London.
 Génie Civil. *w.* Paris.
 Gesundheits-Ingenieur. *s-m.* München.
 Giorn. Dei Lav. Pubbl. e d. Str. Ferr. *w.* Rome.
 Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
 Horseless Age. *m.* New York.
 Ice and Refrigeration. *m.* New York.
 Indian and Eastern Engineer. *m.* Calcutta.
 Iron Age. *w.* New York.
 Iron and Coal Trades Review. *w.* London.
 Iron & Steel Trades Journal. *w.* London.
 Iron Trade Review. *w.* Cleveland.
 Journal Assn. Eng. Societies. *m.* Philadelphia, U. S. A.
 Journal of Electricity. *m.* San Francisco.
 Journal Franklin Institute. *m.* Philadelphia.
 Journal of Gas Lighting. *w.* London.
 Journal Royal Inst. of Brit. Arch. *s-gr.* London.
 Journal of Sanitary Institute. *gr.* London.
 Journal of the Society of Arts. *w.* London.
 Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
 Journal Western Soc. of Eng. *b-m.* Chicago.
 Journal of Worcester Poly. Inst., Worcester, Mass.
 L'Energie Electrique. *w.* Paris.
 Locomotive. *m.* Hartford, U. S. A.
 Locomotive Engineering. *m.* New York.
 Machinery. *m.* London.
 Machinery. *m.* New York.
 Marine Engineering. *m.* New York.
 Marine Review. *w.* Cleveland, U. S. A.
 Metal Worker. *w.* New York.
 Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
 Mines and Minerals. *m.* Scranton, U. S. A.
 Mining and Sci. Press. *w.* San Francisco, U. S. A.
 Mining Reporter. *w.* Denver, U. S. A.
 Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
 Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
 Modern Machinery. *m.* Chicago.
 Moniteur des Architects. *m.* Paris.
 Moniteur Industriel. *w.* Paris.
 Municipal Engineering. *m.* Indianapolis, U. S. A.
 National Builder. *m.* Chicago.
 Nature. *w.* London.
 Nature. *w.* Paris.
 Nautical Gazette. *w.* New York.
 New Zealand Mines Record. *m.* Wellington.
 Nineteenth Century. *m.* London.
 North American Review. *m.* New York.
 Oest. Monatsschr. f. d. Oeff. Baudienst. *w.* Vienna.
 Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
 Ores and Metals. *w.* Denver, U. S. A.
 Plumber and Decorator. *m.* London.
 Popular Science Monthly. *m.* New York.
 Power. *m.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Soc. Civil Engineers. *m.* New York.
 Proceedings Engineers' Club. *gr.* Philadelphia, U. S. A.
 Proceedings St. Louis R'way Club. *m.* St. Louis, U. S. A.
 Progressive Age. *s-m.* New York.
 Railroad Car Journal. *m.* New York.
 Railroad Gazette. *w.* New York.
 Railway Age. *w.* Chicago.
 Railway & Engineering Review. *w.* Chicago.
 Review of Reviews. *m.* London & New York.
 Revue de Mécanique. *m.* Paris.
 Revue Gen. des Chemins de Fer. *m.* Paris.
 Revue Technique. *b-m.* Paris.
 Revue Universelle des Mines. *m.* Liège.
 Rivista Marittima. *m.* Rome.
 Sanitary Plumber. *s-m.* New York.
 Schweizerische Bauzeitung. *w.* Zürich.
 Scientific American. *w.* New York.
 Scientific Am. Supplement. *w.* New York.
 Stahl und Eisen. *s-m.* Düsseldorf.
 Stevens' Institute Indicator. *gr.* Hoboken, U. S. A.
 Stone. *m.* New York.
 Street Railway Journal. *m.* New York.
 Street Railway Review. *m.* Chicago.
 Telephone Magazine. *m.* Chicago.
 Tramway & Railway World. *m.* London.
 Trans. Am. Ins. Electrical Eng. *m.* New York.
 Trans. Am. Ins. of Mining Eng. *m.* New York.
 Trans. Am. Soc. of Civil Eng. *m.* New York.
 Trans. Am. Soc. of Heat & Ven. Eng. *m.* New York.
 Trans. Am. Soc. Mech. Engineers. *m.* New York.
 Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
 Transport. *w.* London.
 Western Electrician. *w.* Chicago.
 Wiener Bauindustrie Zeitung. *w.* Vienna.
 Yacht. *w.* Paris.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
 Zeitschrift für Elektrochemie. *w.* Halle a. S.
 Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Chimneys.

A 360-Foot Single-Shell Chimney. Illustrated description of a stack 360 ft. high and 10 to 20 ft. in diameter inside, built of radial perforated brick. 700 w. Eng Rec—Jan. 26, 1901. No. 39013.

The Building and Repairing of Tall Chimneys. Illustrates and describes methods of accomplishing difficult work. 1200 w. Sci Am—Jan. 12, 1901. No. 38643.

Exposition Building.

The Agricultural Building at the Pan-American Exposition. Illustrated description of the wooden framing of a 500 x 150 ft. exhibition building; the details of the carpenter work are fully explained. 1200 w. Eng Rec—Jan. 12, 1901. No. 38765.

Hospitals.

Hospital Construction from a Medical Standpoint. Henry M. Hurd. Considers the arrangement of buildings, heating and ventilation, precautions against fire, floors, walls, etc. 4000 w. Br Build—Dec., 1900. No. 38501 D.

Sanitary Construction.

Some Sanitary Aspects of House Construction. William Wallace. Read before the Congress of the San. Inst., at Glasgow. Discusses points in construction essential in securing pure, dry air for buildings. 2800 w. Dom Engng—Jan. 15, 1901. No. 38820 C.

Waterproofing.

Waterproofing the Basement of the Government Printing Office Building. John S. Sewell. A description of the tile drains and waterproofing courses at this large structure. 800 w. Eng Rec—Jan. 12, 1901. No. 38764.

HEATING AND VENTILATION.

Combination Systems.

Proportioning Hot-Water Radiation in Combination Systems of Hot Air and Hot Water Heating. R. C. Carpenter. Read at meeting of Am. Soc. of Heat. & Ven. Engs. Gives results of some experiments in proportioning heating surface in a hot air furnace to hot water radiation and an accurate test of the efficiency of the different parts of a furnace and combined with a hot water heater. 2500 w. Met Work—Jan. 26, 1901. No. 38875.

Forced Ventilation.

Mechanical Ventilation and Heating by a Forced Circulation of Warm Air. Walter B. Snow. Gives an illustrated descrip-

tion of this combined system, stating its advantages, and showing its adaptation to various types of buildings. 4800 w. Jour Worcester Poly Inst—Jan., 1901. No. 38860 C.

Heating.

Heating Apparatus at the Exposition of 1900 (Les Appareils de Chauffage à l'Exposition de 1900). F. Dommer. The first of a series of articles reviewing the warming apparatus shown, including steam, hot water, hot air, and isolated heating. Serial. Part I. 1500 w. Génie Civil—Dec. 15, 1900. No. 38902 D.

Hot Water.

A Low Pressure Hot Water Heating System Receiving Heat from a Steam Boiler. John Gormly. Read at meeting of Am. Soc. of Heat. & Ven. Engs. Illustrates and describes a device containing features of interest. 1000 w. Met Work—Jan. 26, 1901. No. 38873.

Heating of the Westminster Chambers, Boston. Illustrated description of a hot-water heating plant in an 8-story, 104 x 145 ft. apartment house. 1000 w. Eng Rec—Jan. 5, 1901. No. 38570.

Japanese Palace.

Ventilating and Heating the Palace of the Crown Prince of Japan. Illustrated description of a hot blast steam apparatus for warming the main apartments of this palace, direct-radiation for the basement and corridors and a cooling system for use in summer. 3100 w. Eng Rec—Jan. 19, 1901. No. 38792.

Standardisation.

Report of Committee on Standards. Code for Testing Direct Radiation Heating Plants. Report presented at N. Y. meeting of the Am. Soc. of Heat. & Ven. Engs. 3400 w. Met Work—Jan. 26, 1901. No. 38874.

Station Heating.

Central Station Heating. Illustrated abstract of paper by William H. Bryan, presented at meeting of Am. Soc. of Heat. & Ven. Engs., on the financial features of public steam and hot-water heating service by electric companies. 3300 w. Eng Rec—Jan. 26, 1901. No. 39017.

Steam Heating.

Low-Pressure Steam Heating in France. Gustave Debesson. Illustrated extracts from a paper presented to the Am. Soc. of Heat. & Ven. Engs., describing typical French gravity systems, with special radiator valves and copper pipe joints. 1200 w. Eng Rec—Jan. 26, 1901. No. 39018.

Ventilation.

Natural Ventilation (Ueber Natürliche Lüftung). W. Mehl. An examination of the manner in which air becomes fouled, and of the best method of inducing currents to provide for the necessary change by natural means. Two articles, 1 plate. 7500 w. *Gesundheits Ingenieur*—Dec. 15, 31, 1900. No. 38948 each B.

Vitiated Air.

The Air of Buildings and Sewers. J. S. Haldane. Read at the Bolton Congress of

the San. Inst. of Gt. Britain. Gives results of recent experimental researches and the conclusions reached. 3600 w. *Dom Engng*—Jan. 15, 1901. Serial. 1st part. No. 38819 C.

PLUMBING AND GAS FITTING.**Fittings.**

Sanitary Fittings and Plumbing. The introduction to a series of articles discussing modern practice. 2000 w. *Builder*—Jan. 5, 1901. Serial. 1st part. No. 38712 A.

CIVIL ENGINEERING

BRIDGES.**Bridge Practice.**

Three Questions Respecting Bridge Practice. Edward Godfrey. States three questions for discussion, giving personal views. 900 w. *Eng News*—Jan. 24, 1901. No. 39004.

Bridge Shop.

See Mechanical Engineering, Machine Works and Foundries.

Drawbridges.

Competitive Designs for the 95th St. Bascule Bridge Over the Calumet River, Chicago. Illustrated description of accepted and submitted designs. 4800 w. *Eng News*—Jan. 10, 1901. No. 38646.

New Systems of Drawbridges in America (Neuere Systeme Beweglicher Brücken in den Vereinigten Staaten von America). Describing the Harman, Schinke, and Scherzer systems of drawbridges. 2500 w. *Zeitschr d Oesterr Ing u Arch Ver*—Dec. 21, 1900. No. 38932 B.

Permanence.

The Permanence of Iron and Steel Structures. An editorial on the possibility of preserving inaccessible parts of a bridge structure by embedding them in cement. 1000 w. *Eng Rec*—Jan. 5, 1901. No. 38564.

Renewal.

Driving Difficult Piles for a Bridge Renewal. Describes method of building bents across a long railway bridge without interrupting traffic. 600 w. *Eng Rec*—Jan. 19, 1901. No. 38790.

Rouen.

The Hanging Bridge at Rouen (Die Ueberfuhrbrücke in Rouen). H. Franz. An illustrated account of the high-level suspension bridge, with low-level hanging transport platform recently erected at Rouen. 1500 w. 1 plate. *Oesterr Monatschr f d Oeffent Baudienst*—Jan., 1901. No. 38946 D.

Swing-Bridges.

Converting a Fixed Bridge Span Into a Swing Span. Illustrates and describes an interesting piece of work on the Pere Marquette R. R. at New Richmond, Mich., carried out without interrupting traffic. 600 w. *Eng News*—Jan. 17, 1901. No. 38783.

The Charlestown Swing Bridge, Boston, Mass. Illustrated description of a recently completed bridge, particularly remarkable for its width of 100 ft., which is continuous over the swing span, for being a double-deck structure throughout, and for the heavy and solid character of its substructure and foundation work. 2500 w. *Eng News*—Jan. 24, 1901. No. 39002.

Viaduct.

The Gokteik Viaduct, Burmah. Illustrated description of a steel viaduct 2,260 ft. long and 320 ft. in maximum height. The general features of the structure and its erection are explained. 2300 w. *Eng Rec*—Jan. 12, 1901. Serial. 1st part. No. 38760.

The Kinzua Viaduct of the Erie Railroad Company. George S. Morison, R. S. Buck and L. S. Moisseiff. Discussion of paper by C. R. Grimm. 5500 w. *Pro Am Soc of Civ Engs*—Jan., 1901. No. 38885 E.

CONSTRUCTION.**Columns.**

The Practical Column Under Central or Eccentric Loads. Albert I. Frye. Continued discussion of paper by J. M. Moncrieff. 500 w. *Pro Am Soc of Civ Engs*—Jan., 1901. No. 38884 E.

Dry Dock.

Additional Particulars of the Floating Dry Dock for Algiers, La. Particulars and details of the construction. Ill. 2000 w. *Marine Engng*—Jan., 1901. No. 38693 C.

Fire-proofing.

The New York Fire Insurance Exchange Schedule. Discusses some features of this

schedule. 1000 w. Br Build—Dec., 1900. No. 38502 D.

Foundations.

On the Use of Monier Pipes as a Pipe Covering, and in Place of Cast Iron for Cylinder Foundations. Ernest Macartney de Burgh. An illustrated article favoring the use of pipes constructed on the Monier principle, to protect pipes from attacks of the Teredo navalis. 1400 w. Prac Engr—Jan. 4, 1901. No. 38707 A.

Graphostatics.

Framed Structures Examined by Graphical Statics (Beweis Einiger Konstruktionen mit Hülfe der Graphischen Statik). M. Kinkel. Giving the application of graphical statics to certain forms of curved trusses. 1200 w. Schweizerische Bauzeitung—Jan. 12, 1901. No. 38941 B.

Hinged Arch.

The Pointed Arch with Free Hinged Springings (Der Spitzbogenträger mit Frei Drehbaren Kämpfergelenken). Adolf Francke. A mathematical investigation of the forces in hinged Gothic arches of various forms and loadings. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 28, 1900. No. 38933 B.

Piers.

The New Fireproof Piers of the North German Lloyd Steamship Co., at Hoboken, N. J. Illustrated detailed description of important fireproof construction, with editorial. 5500 w. Eng News—Jan. 3, 1901. No. 38549.

Retaining Walls.

Masonry Dams and Retaining Walls in General, Concrete Works, etc. Charles Baillaige. Remarks on retaining walls in Quebec, their failures and rebuilding. Also considers stone or masonry dams, concrete dams, and curved or bowed dams. 6800 w. Can Soc of Civ Engrs—Adv. Proof—Jan. 3, 1901. No. 38624 D.

Roads.

Facts and Fallacies Concerning Good Roads. Letter from Martin Dodge, replying to criticisms of the Road Inquiry Bureau's statistics, with editorial. 6000 w. Eng News—Jan. 17, 1901. No. 38785.

Progress of Road Building in the United States. Maurice O. Eldridge. A review of the early roads of the country, and of the progress made in various parts of the country. 3000 w. Brick—Jan. 1, 1901. No. 38577.

The New Jersey State Road System. William L. Dickinson. A description of the results of the New Jersey State road law. 1800 w. Eng Rec—Jan. 19, 1901. No. 38791.

Tunneling.

Section Third of the New York Rapid Transit Subway. Illustrated description of a four-track subway in an important

New York street, built by the cut and cover method, without disturbing four street railway tracks. 2500 w. Eng Rec—Jan. 12, 1901. No. 38763.

The Cascade Tunnel, Great Northern Ry. John F. Stevens. The crossing of the summit of the Cascades has been effected by means of a switchback. A long tunnel has now been completed which will do away with this switchback. The methods of construction are illustrated and described. 3800 w. Eng News—Jan. 10, 1901. No. 38647.

The Construction of Railroad Tunnels. J. V. Davies. Reviews the various methods of underground construction of tunnels and subways. Illustrations and general discussion. 12000 w. N Y R R Club—Dec. 20, 1900. No. 38668.

The Hastings Tunnel Shield, Chicago Intercepting Sewers. A description, by the City Engineering Department of Chicago, of two shields, 25 ft. in diameter, used in clay. 1400 w. Eng Rec—Jan. 19, 1901. No. 38789.

Tunneling Through Fine Sand. Illustrated description of a method of driving a heading for a 6½ ft. sewer by canvas backing for the lagging and cantilever supports for the top poling boards. 1200 w. Eng Rec—Jan. 26, 1901. No. 39011.

HYDRAULIC AND MARINE.

Canals.

Design for Controlling Works at the Head of the Chicago Drainage Canal. Abstract of a paper read by Ossian Guthrie before the W. Soc. of Engrs. Illustrated description of proposed works, consisting of a lock the full width of the canal, subdivided by a central wall, the left-hand channel being a by-pass and the right-hand channel a lock. 2500 w. Eng News—Jan. 3, 1900. No. 38547.

Internal Waterways at the Paris Exposition (Die Binnenschiffahrts-Canäle auf der Pariser Weltausstellung 1900). Richard Kuhn. A review of the internal waterways of various countries as illustrated by exhibits at Paris. 5000 w. 2 plates. Oesterr Monatschr f d Oeffent Bauindustri—Jan., 1901. No. 38947 D.

Russia's System of Internal Waterways. A. H. Ford. In the first of an important series of papers on the development of Russia the question of the importance of transport as an element in the expansion of manufactures and trade is discussed. 3500 w. Engineering Magazine—Feb., 1901. No. 38974 B.

The Engineering Works of the Suez Canal. Condensation of a report to the Inst. C. E. by Sir Charles Hartley, being the first complete report in English. 5000 w. Eng Rec—Jan. 5, 1901. No. 38571.

The Nicaragua Canal Question and the Clayton-Bulwer Treaty. Robert Brom-

ley. A discussion of the Hepburn Bill, the Clayton-Bulwer Treaty, and international matters relating to the construction of this canal. 7300 w. Nineteenth Cent—Jan., 1901. No. 38794 D.

Docks.

The River Ribble and Preston Dock. A review of the Commissioner's Report and of the recent report of the resident engineer, Mr. A. F. Fowler, concerning the work accomplished. 2200 w. Engr, Lond—Jan. 18, 1901. No. 39032 A.

Dredges.

Dredges for the New 40-Foot Channels of New York Harbor. Describes the work proposed, giving map, and gives illustrated description of the dredge "Thomas," specially constructed for this work. 1400 w. Sci Am—Jan. 12, 1901. No. 38644.

The Bates Hydraulic Dredger. An illustrated description of a dredger for the port of Rockhampton, Queensland. 2000 w. Engng—Jan. 11, 1901. No. 38833 A.

Filtration.

A Proposed New System of Mechanical Filtration for Louisville, Ky. Describes a new system developed by Charles Hermany. Ill. 1500 w. Eng News—Jan. 17, 1901. No. 38787.

Covers for Slow Sand Water Filters. Allen Hazen. From a report to the Trenton Water Board on "Pollution and Filtration of the Delaware River Water Supply for the City of Trenton, N. J." Discusses points to be considered in deciding whether or not to cover filters, with the writer's reasons for recommending open filters. 4500 w. Eng News—Jan. 24, 1901. No. 39001.

Filtration and Meterage at Norfolk, Va. Illustrates and describes the plant, giving information also of the supply, waste, etc. 1800 w. Fire & Water—Jan. 5, 1901. No. 38639.

Notes on Designing and Constructing Slow Sand Filters. James H. Fuertes. A discussion of the method of estimating the total area of filters and the size of the individual beds. 2000 w. Eng Rec—Jan. 26, 1901. Serial. 1st part. No. 39012.

The Mechanical System of Water Filtration. Floyd Davis. Describes the filters and their operation. 1000 w. Munic Engng—Jan., 1901. No. 38481 C.

Ground Water.

The Ground-Water Supply for Sternberg and Witkowitz, in Moravia (Gewinnung des Grundwassers für die Wasserversorgung von Sternberg und Witkowitz in Mähren). Prof. A. Oelwein. With topographical maps of the territory, and sections of the wells and filters. 3000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Dec. 14, 1900. No. 38931 B.

Harbors.

An Internal Harbor System for Chicago. Albert H. Scherzer. Suggests a plan for maintaining and extending the railroad and water transportation interests, showing its advantages, and giving outline maps. Also editorial. 2500 w. Ry Age—Jan. 11, 1901. No. 38755.

The Ports of Tunis (Les Ports Tunisiens). G. Leugny. Especially describing the harbor of Bizerte, and the recent improvements. 3000 w. Revue Technique—Jan. 10, 1901. No. 38913 D.

Harbors and Waterways in the Nineteenth Century. Reviews the progress in Great Britain, and the great improvements made. 6000 w. Engr, Lond—Jan. 4, 1901. No. 38734 A.

Irrigation.

Irrigation Farming in the Southwest. D. Allen Willey. Describes methods of irrigation in Louisiana, for the cultivation of rice. Ill. 1500 w. Sci Am—Jan. 26, 1901. No. 38869.

Irrigation in the Hawaiian Islands. Wade Warren Thayer. Illustrated description of an engineering feat which brings a supply of 50,000,000 gallons of water daily, a distance of 22 miles, through a very difficult region. 700 w. Sci Am—Jan. 12, 1901. No. 38642.

Lake Nicaragua.

The Water Supply of Lake Nicaragua. Angelo Heilprin. A reply to criticisms by the hydrographer of the Nicaragua Canal Commission. 1700 w. Sci Am Sup—Jan. 12, 1901. No. 38645.

Progress.

A Century's Progress. A review of the progress made during the last century in hydraulic and sanitary engineering. 2000 w. Fire & Water—Jan. 5, 1901. Serial. 1st part. No. 38640.

Pumping.

Duluth's Municipal Pumping Plant. Illustrates and describes the pumping engines of this plant. 800 w. Power—Jan., 1901. No. 38641.

Reading, Pa.

Reading and Its Reservoirs. Illustrates and describes the present water-works system, and the difficulties encountered because of the city being built on a slope. 1000 w. Fire & Water—Jan. 26, 1901. No. 39045.

River Improvements.

Improvements at the Mouth of the Yazoo River. Brief account of the work in progress for the improvement of the harbor of Vicksburg, and of navigation on the Yazoo River. Maps and Ill. 900 w. Ry & Engng Rev—Jan. 26, 1901. No. 39046.

The Artificial Feeding of the Nests

(L'Alimentation Artificielle de la NESTE). P. Frick. An account of the manner in which some lakes of the Pyrenees have been tapped to supply an agricultural district. 2000 w. Génie Civil—Jan. 12, 1901. No. 38907 D.

The Extended Navigation on the Monongahela River. F. L. Emory. Briefly reviews the history of locks and dams for river improvement, and gives an account of the proposed work on the river named. 3400 w. Jour Worcester Poly Inst—Jan., 1901. No. 38858 C.

The Improvement of the Illinois and Des Plaines Rivers. Extracts from a report by U. S. engineer officers against the extension of deep water navigation from the Chicago drainage canal to the Mississippi, unless Congress authorizes a corresponding improvement of that river. 1800 w. Eng Rec—Jan. 5, 1901. No. 38565.

Stand-Pipes.

Deterioration of the Peoria Stand-Pipes. Dabney H. Maury. Reply to a review by Albert B. Herrick of a paper by the writer on "Electrolysis of Underground Metal Structures." Also a note from A. A. Knudson. Ill. 2800 w. Eng News—Jan. 24, 1901. No. 39005.

Water Analysis.

Permanent Standards for Use in the Analysis of Water. Daniel D. Jackson. Describes the permanent standards already employed, and considers in detail the new standards proposed. 3500 w. Tech Quar—Dec., 1900. No. 38771 E.

The Evolution of the Oxygen Absorption Test in Water and Sewage Analysis. J. W. Weems. Extract from a paper before the Iowa Engng Soc. Historical sketch, giving the scheme of each test of this nature and an explanation of the proper interpretation of the results of these tests. 1200 w. Eng Rec—Jan. 26, 1901. Serial. 1st part. No. 39015.

Water Meters.

Testing Large Water Meters. Lewis H. Nash. Illustrated description of the apparatus used. 800 w. Stevens Ind—Jan., 1901. No. 38890 D.

Water-Power.

A Wonderful Water Power. F. E. Santos. Illustrated description of the springs of Fossil Creek, Arizona. 800 w. Elec Rev, N. Y.—Jan. 26, 1901. No. 38877.

Water Purification.

Water Purification in Louisville. Part first gives an illustrated description of the construction of concrete clear-water basins and concrete-steel vaulting. 1800 w. Eng Rec—Jan. 5, 1901. Serial. 1st part. No. 38567.

Water Supply.

Protection of Underground Water Supplies. W. Matthews. Read at meeting

of the British Assn. of Water-Works Engs. Discusses British law for the protection of water supplies, and describes cases that have come under the writer's notice. General discussion. 4200 w. Jour Gas Lgt—Dec. 25, 1900. No. 38603 A.

Public Water Supplies. George R. Perry. From a paper before the Charleston convention of the League of Am. Munic. A discussion of waste, unrestricted use, meters, etc. 2200 w. Munic Engng—Jan., 1901. No. 38484 C.

The Future of the London Water Supply. R. E. Middleton. Read before the Surveyor's Inst., England. States the estimated population to be provided for, the amount of water to be afforded, the sources, etc. 8000 w. Jour Gas Lgt—Dec. 25, 1900. No. 38604 A.

Water Supply. Editorial on the wonderful progress of the nineteenth century; the review is confined principally to Great Britain. 2500 w. Engr, Lond—Jan. 4, 1901. No. 38743 A.

Water-Works.

The Babylon Water Supply Plant. Illustrated description of works in which water is pumped from wells into four tanks where an air pressure of 45 lbs. is maintained, as a substitute for the head furnished by a water tower. The compressed air is drawn from tanks through regulating valves, maintaining a constant pressure on the water, without regard to the pressure in the air tanks. 1000 w. Eng Rec—Jan. 12, 1901. No. 38761.

The Hartford Vitrified Water Conduit. W. E. Johnson. Abstract of a paper read before the Conn. Soc. of Engs. & Survs. Describes a conduit 16,700 ft. long and 24 in. in diameter, constructed of vitrified clay pipe. The requirements for the pipe and methods of laying it are explained in detail. 1300 w. Eng Rec—Jan. 12, 1901. No. 38762.

The Water-Works Plant of the Pearl River Lumber Co., Brookhaven, Miss. William C. Porter. Describes a well-arranged plant for protection against fire, and for supplying water for uses about a large manufacturing plant. 600 w. Eng News—Jan. 10, 1901. No. 38650.

MATERIALS.

Concrete.

The Concrete Question. William E. Smith. Information relating to the use of concrete by a writer of experience. 1800 w. Ry & Engng Rev—Jan. 26, 1901. No. 39048.

Glazed Bricks.

The Manufacture of Glazed Bricks. F. Walker. Discussing kiln firing, white and colored bricks, clay analyses, etc. 1700 w. Brick—Jan. 1, 1901. Serial. 1st part. No. 38578.

Paving Materials.

Concerning Retene, Petrolene and Asphaltene. S. F. Peckham. A protest against the use of these words, with reasons. 4000 w. Jour Fr Inst—Jan., 1901. No. 38658 D.

MEASUREMENT.**Spirit Leveling.**

The Theory and Practice of Precise Spirit Leveling. W. S. Williams, J. A. Ockerson, and C. L. Crandall. Continued discussion of paper by David A. Molitor. 3500 w. Pro Am Soc of Civ Eng—Jan., 1901. No. 38883 E.

Surveying.

Recent Contributions to Our Knowledge of the Earth's Shape and Size, by the United States Coast and Geodetic Survey. C. A. Schott. An account of the work, with chart and explanatory notes. 2200 w. Nat Geog Mag—Jan., 1901. No. 38-836 C.

Triangulation.

The Transcontinental Triangulation and the American Arc of the Parallel. John E. McGrath. On the importance of this work and the value of the report, with information relating to the work. 3500 w. Eng News—Jan. 3, 1901. No. 38548.

MUNICIPAL.**Havana.**

The Renovation of Havana. An illustrated article considering the street work as given in Col. Black's report. 2500 w. Eng Rec—Jan. 19, 1901. Serial. 1st part. No. 38788.

Pavements.

Repairs to Asphalt Pavements in Buffalo. Extracts from a report by City Engineer F. V. E. Bardol, describing the nature of the failures of asphalt, and methods of preventing and repairing them. 2400 w. Eng Rec—Jan. 5, 1901. No. 38-569.

Sanitation.

Sanitary Engineering. Editorial review of progress made during the last year in sewage disposal. 1800 w. Engr, Lond—Jan. 4, 1901. No. 38742 A.

Sewage.

Bacterial Treatment of London Sewage and American Sewage Disposal Problems. Editorial discussion of the report of Dr. Clowes and Dr. Houston, relating to the London experiments. 1800 w. Eng News—Jan. 24, 1901. No. 39003.

Sewage Purification.

The Function of the Septic Tank in Sewage Purification (Ueber Zweck und Bedeutung des Faulraumes bei Abwasserreinigungs-Anlagae). Dr. O. Kröhnke. A general discussion of the septic tank, showing the conditions under which it

may be useful. 3500 w. Gesundheits-Ingenieur—Jan. 15, 1901. No. 38949 B.

Sewerage.

Flow in the Sewers of the North Metropolitan Sewerage System of Massachusetts. Theodore Horton. Describes three series of observations made in the channels below the Charlestown and East Boston pumping stations, and the methods used. Ill. 2700 w. Pro Am Soc of Civ Eng—Jan., 1901. No. 38882 E.

New Sewage Works in Paris. Concerning measures in progress for solving the sewage question. 1200 w. Engr, Lond—Jan. 11, 1901. No. 38809 A.

The Sewerage System and Sewage Farm of the Melbourne and Metropolitan Board of Works. Describes this great piece of sewerage work, giving related information regarding cost, connections, and other matters of interest. 3200 w. Eng News—Jan. 24, 1901. No. 39006.

A Sewer Inlet Plan. H. M. Miles. Illustrates and describes the construction of highly satisfactory catch-basins, easily kept clean. 700 w. Munic Engng—Jan., 1901. No. 38483 C.

Vienna.

Project for a Jubilee Place in Vienna (Project zur Schaffung eines Kaiser Franz Josef Jubiläums platzes in Wien). A. Lotz. With plans showing the possibility of making many street improvements in Vienna and the creation of a place in commemoration of the Jubilee of the Emperor Francis Joseph. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 11, 1901. No. 38934 B.

MISCELLANY.**Address.**

The Evolution of Science (L'Evolution de la Science à Travers les Siècles). Maurice Levy. The annual address of the President of the Académie des Sciences of France, reviewing the progress of science in past centuries. 6000 w. Comptes Rendus—Dec. 17, 1900. No. 38950 D.

Education.

On the Need of the Education of the Judgment in Dealing with Technical Matters. George W. Dickie. Calls attention to the lack of sound judgment exhibited in dealing with engineering problems. 2700 w. Jour Assn of Engng Socs—Dec., 1900. No. 38822 C.

The Present Problem in Technical Education. Editorial, discussing the need of scientific instruction less extended in scope than that given in technical schools. 1400 w. Eng Rec—Jan. 26, 1901. No. 39010.

Review.

Civil Engineering. Editorial review of the nineteenth century work in this field, and noting the more prominent results. 4600 w. Engr, Lond—Jan. 4, 1901. No. 38739 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

Ocean Cables Should Be of American Make. J. W. Marsh. Discusses the subject of cables and their manufacture, urging the extension of the industry in the United States. 4500 w. Am Mfr—Jan. 10, 1901. No. 38756.

The Influence of Submarine Cables Upon Military and Naval Supremacy. George O. Squier. Showing the importance of submarine cables in national defence, and discussing the existing and proposed systems of the United States and Gt. Britain. 7500 w. Nat Geog Mag—Jan., 1901. No. 38835 C.

The Outlook for the Submarine Cable Industry in the Twentieth Century. Charles Bright. Considers the outlook better than for some years, and gives views in regard to the Pacific cable proposed. 1500 w. Elec Rev, Lond—Jan. 11, 1901. No. 38797 A.

Independent Telephones.

The Rise, Growth and Present Extent of the Independent Telephone Movement. James M. Thomas. 2700 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38721.

Long Distance.

An Important Telephone Invention Appreciated. Brief account of Dr. Pupin's patents covering the art of ocean telephony, sold to the Bell Co. for a large sum. 1200 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38728.

Dr. Pupin's Improvements in Long-Distance Telephony. Herbert T. Wade. An explanation of Dr. Pupin's investigations and their great success and the application to long-distance telephony and to telegraphy. Ill. 2500 w. Sci Am Sup—Jan. 26, 1901. No. 38872.

Philippines.

Telegraph Operators in the Philippines. F. E. Grain. Information concerning the need of operators and the requirements. 2400 w. Elec Wld & Engr—Jan. 19, 1901. No. 38817.

Printing Telegraph.

A New Page-Printing Telegraph. William B. Vansize. Reviews other work in this field, and gives illustrated detailed description of system invented by Donald Murray. 7000 w. Trans Am Inst of Elec Engrs—Jan., 1901. No. 39054 D.

Ship Telegraph.

The Violet-Chabrand Ship Telegraph (Transmetteur d'Ordres, Système Violet-Chabrand). G. Dary. An illustrated description of an improved electric dial tele-

graph for the transmission of orders from the bridge of a vessel to the engine-room. 1800 w. L'Electricien—Dec. 29, 1900. No. 38969 B.

Space Telegraphy.

Determinate and Multiple Spark Telegraphy (Abgestimmte und Mehrfache Funkentelegraphie). Prof. A. Slaby. A review of the writer's experiments, with especial reference to space telegraphy between determinate points. 6000 w. Elektrotech Zeitschr—Jan. 10, 1901. No. 38965 B.

Prof. Slaby's Tunnel and Multiple Spark Telegraphy. Abstract of a lecture delivered before the German Emperor, at Berlin. 1100 w. Elect'n, Lond—Jan. 18, 1901. No. 39000 A.

Some Experiments on the Propagation of Hertzian Waves Along a Wire, and Through the Air. Emile Guarini. An account of experiments made with a simple telephone as a receiver. 2500 w. Elec Rev, Lond—Jan. 11, 1901. Serial. 1st part. No. 38802 A.

Wireless Telegraphy. Arthur V. Abbott. Reviews briefly the discoveries that have made wireless telegraphy possible and its present standing. 2500 w. Elec Wld & Engr—Jan. 5, 1901. No. 38677.

Submarine.

Line-Wave Submarine Cable Telegraphy. A review of a recent paper by Albert C. Crehore and George O. Squier, read before the Am. Inst. of Elec. Engrs. Ill. 4000 w. Engng—Jan. 4, 1901. No. 38729 A.

Telegraphy.

The Telegraph. Patrick B. Delany. Historical review. 3600 w. Elec Wld & Engr—Jan. 5, 1901. No. 38681.

The Telegraph in the Nineteenth Century. William Maver, Jr. An interesting review of the history and development, with portraits of S. F. B. Morse and Cyrus W. Field. 4500 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38714.

Telephones.

Telephonic Transmission. A discussion of means for increasing the inductance, considering Dr. Pupin's work and results obtained by other investigators. 2000 w. Elec Rev, Lond—Jan. 4, 1901. Serial. 1st part. No. 38701 A.

The History of the Invention and Development of the Speaking Telephone. George C. Maynard. Interesting historical account, with portraits. 5000 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38717.

The Railway Telephone. E. A. Chenery.

Discusses the use of telephones in railway work, and thinks a great deal of work now done by telegraph must be done by the telephone. Gives plate of the N. Y., N. H. & H. R. R. telephone systems. 2800 w. St Louis Ry Club—Dec. 14, 1900. No. 38522.

Telephone Exchange.

The Construction of Small Telephone Exchanges. A. E. Dobbs. Gives a copy of a franchise considered fair for the average town, with comments. 2000 w. Elec Rev, N. Y.—Jan. 5, 1901. No. 38552.

The Independent Telephone Exchange at Atlanta, Ga. E. E. Clement. Illustrated description of the main features of a large modern telephone exchange, in which the trunking principle has been successfully used throughout. 2100 w. Am Elect'n—Jan., 1901. No. 38630.

The Multiple Telephone Exchange System of Mix and Genest, for Medium and Small Exchanges (Der Vielfachumschaltbetrieb bei Mittleren und Kleineren Fernsprechämtern nach dem system Mix und Genest). Describing a simplified form of exchange for small telephone systems. 1800 w. Elektrotech Zeitschr—Dec. 20, 1900. No. 38959 B.

Telephonograph.

The Telephonograph (Der Telephonograph). Dr. Rellstab. An examination of the action of the Poulsen telephonograph, showing the condition under which the most accurate records of human speech may be expected. 3000 w. Elektrotech Zeitschr—Jan. 17, 1901. No. 38968 B.

Telephony.

Telephony. Kempster B. Miller. A review of progress and improvements, noting the present tendencies. 1700 w. Elec Wld & Engr—Jan. 5, 1901. No. 38674.

Telephone vs. Telegraph.

Telephone vs. Telegraph on Railroad Lines. G. F. Jenks. Reviews the reasons why the telephone should not supersede the telegraph. 1000 w. Elec Wld & Engr—Jan. 12, 1901. No. 38684.

Transmission.

The Electrical Transmission of Intelligence. Kempster B. Miller. A review of progress made in the telegraph and the telephone. 1700 w. W Elect'n—Jan. 5, 1901. No. 38661.

DISTRIBUTION.

Alternating Currents.

Capacity in Alternate-Current Working. W. M. Mordey. Considers some of the effects of electrostatic capacity in insulated cables for alternate-current working, especially as regards the power and plant. 3700 w. Elect'n, Lond—Jan. 18, 1901. Serial. 1st part. No. 38899 A.

Electrical Oscillations and Electric

Waves. J. A. Fleming. Cantor lecture. The first of a series of lectures studying this subject. The present article considers the practical method of producing electrical oscillations, experimental investigations, frequency, etc. Ill. 7800 w. Jour Soc of Arts—Dec. 28, 1900. Serial. 1st part. No. 38605 A.

Alternators.

European Types of High-Tension Alternators. C. F. Guilbert. An account of a careful study made of the alternators exhibited at the Paris Exposition. 2500 w. Elec Wld & Engr—Jan. 19, 1901. No. 38812.

Graphical Treatment of the Effect of Armature Current on Wave Form of Alternator. F. G. Baum. The effect is shown graphically and explained. 600 w. Elec Wld & Engr—Dec. 29, 1900. No. 38497.

Circuits.

The Calculation of Alternating-Current Electro-Magnetic Circuits. Harold B. Smith. Considers circuits in which the magnetic flux is periodically varying in both quantity and direction; hysteresis, eddy or Foucault currents, inductance, etc. Charts. 2200 w. Jour Worcester Poly Inst—Jan., 1901. Serial. 1st part. No. 38859 C.

Conductors.

Aluminum Conductors for Electrical Power Distribution. William Hoopes. Gives data relating to cost, and briefly considers the reliability, durability and maintenance. 1100 w. St Ry Rev—Jan. 15, 1901. No. 38857 C.

The Use of Aluminum as an Electrical Conductor, with New Observations Upon the Durability of Aluminum and Other Metals Under Atmospheric Exposure. John B. C. Kershaw. Abstract of a paper read before the British Inst. of Elec. Eng's. 2500 w. Elec Rev, Lond—Jan. 18, 1901. No. 38898 A.

Direct vs. Three-Phase.

Relative Advantages of Direct-Current and Three-Phase Distribution. H. A. Earle. Read at the Manchester Sec. of the Inst. of Elec. Eng's. A comparison of the two systems and a consideration of points which should guide in the choice. 4800 w. Elect'n, Lond—Dec. 28, 1900. No. 38601 A.

Lines.

Practical Line Construction. Loren W. Burch. Read at Milwaukee meeting of Northwestern Electrical Assn. Discusses the requirements of good construction. 2000 w. Elec Rev, N. Y.—Jan. 26, 1901. No. 38879.

Power Distribution.

The Case for Electric Power Distribu-

tion. W. B. Esson. Read before the Civ. and Mech. Engs. Soc., England. Considers the circumstances upon which must depend the decision as to whether electricity can with advantage displace the older method of power distribution. Also general discussion. 1000 w. Elec Engr, Lond—Jan. 11, 1901. No. 38803 A.

Switchboards.

Central-Station Switchboard Connections. J. A. Seager. Discusses points in the arrangement of high and low-tension connections. 1600 w. Elec Engr, Lond—Jan. 4, 1901. No. 38706 A.

Wiring.

Future Development of Interior Wiring. H. Ward Leonard. Describes the method advocated by the writer, and considers the important requirements. 2800 w. Elec Wld & Engr—Jan. 5, 1901. No. 38680.

ELECTRO-CHEMISTRY.

Accumulators.

Development of the Use of the Storage Battery in the United States. Charles Blizard. Historical outline. 1600 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38723.

Pastes for Accumulator Plates. Translation of article in the *Centralblatt für Accumulatoren und Elementenkunde*, describing experiments made by Dr. Peters. 1500 w. Elect'n, Lond—Jan. 4, 1901. No. 38751 A.

The Electric Accumulator. H. C. Schaerer. Read before the Elec. Assn. of N. S. W. Reviews the work in this field, explains the chemical action, and traces the progress made. 3200 w. Aust Min Stand—Nov. 29, 1900. No. 38506 B.

The Storage Battery. Augustus Treadwell, Jr. Historical review, with an account of the uses to which storage batteries have been applied and the success attained. 4000 w. Elec Wld & Engr—Jan. 5, 1901. No. 38678.

Zinc Negatives for Electric Accumulators. Briefly reviews the difficulties met with in employing zinc negatives, and the absolute necessity for purity of all materials used in cells, etc. 1600 w. Auto Jour—Jan., 1901. No. 39009 A.

Electro-Chemistry.

Electro-Chemistry. Carl Hering. Comments on the rapid progress of the last four years, and reviews what is being accomplished, and the future outlook. 5200 w. Elec Wld & Engr—Jan. 5, 1901. No. 38676.

Electrolytic Refining.

The Present Status of the Electrolytic Refining Industry in the United States. Titus Ulke. Part first considers the refining of copper. Silver and gold will be considered in articles following. 1000 w. Elec Rev, N. Y.—Jan. 12, 1900. Serial. 1st part. No. 38727.

Review.

The Electro-Chemical and Electro-Metallurgical Industries in 1900. John B. C. Kershaw. Gives details of the various industries and processes. 5600 w. Elect'n, Lond—Jan. 4, 1901. Serial, 1st part. No. 38758 A.

ELECTRO-PHYSICS.

Energy.

Electrical Energy Direct from Carbon. A. E. Kennelly. A discussion of this subject, indicating where improvement may be looked for in utilizing the energy of coal. 3000 w. Elec Wld & Engr—Jan. 5, 1901. No. 38670.

Frequency.

A Method of Determining the Frequency of Wave Currents (Ueber eine Methode zur Bestimmung der Frequenz Wellenformiger Ströme). R. K. Hartmann. Discussing the use of the resonator and frequency meter, with reproductions of wave photographs. 4500 w. Elektrotech Zeitschr—Jan. 3, 1901. No. 38962 B.

Induction Coil.

A New Induction Coil. W. C. Peckham. Illustrates and describes a large induction coil made for the Japanese government. 1200 w. Sci. Am—Jan. 5, 1901. No. 38534.

Inertia.

Magnetic Inertia (Ueber Magnetische Trägheit). K. Krogh and H. Rikli. A discussion, graphical and analytical, of the behaviour of soft iron under magnetisation, as occurring in alternating electrical apparatus. 3500 w. Elektrotech Zeitschr—Dec. 27, 1900. No. 38960 B.

Iron Losses.

The Dependence of Iron Losses Upon Curve Forms (Die Abhängigkeit der Eisenverluste von Kurvenform). Dr. G. Benischke. A discussion of hysteresis and eddy currents as influenced by the wave form of the alternating current. 5000 w. Elektrotech Zeitschr—Jan. 17, 1901. No. 38967 B.

Radiography.

A Brief History of the X-Ray. Eugene W. Caldwell. 2200 w. Elec Rev, N. Y. Jan. 12, 1901. No. 38724.

Resistance.

The Diminution of Resistance by Cold (Ueber Widerstandverminderung durch Kälte und deren Theoretische Prüfung). R. Mewes. A discussion of the researches of Tesla, Dewar, and Fleming. 5000 w. Elektrochemische Zeitschrift—Jan. 1, 1901. No. 38973 G.

Theories.

Electrical Theories. John Trowbridge. Reviews the theories that have been ad-

vanced, those discarded, and those attracting attention at the present time. 2000 w. Elec Wld & Engr—Jan. 5, 1901. No. 38669.

GENERATING STATIONS.

Amsterdam.

Electrical Works in Amsterdam. A statement of the cost of establishing an electric plant to furnish electricity for street cars, lighting, and motive power. Also a comparative table of cost in different continental cities of Europe. 1500 w. U. S. Cons Repts, No. 935—Jan. 15, 1901. No. 38704 D.

Bipolar Machines.

Report on Bipolar Machines Exhibited at the Paris Exhibition. R. Lloyd-Pearson. Describes the exhibits, and expresses the opinion that in a few years this class of machine will be extinct. 4800 w. Elec Rev, Lond—Jan. 11, 1901. No. 38801 A.

Central Stations.

A Representative American Central Station. An illustrated detailed description of the plant of the Edison Electric Illuminating Company of Brooklyn. 3800 w. Am Elect'n—Jan., 1901. No. 38626.

Evanston, Ill., Central Station for Heating and Lighting. Illustrates and describes the combination of a hot-water system, supplying heat to a territory of six or eight square miles, and an electric-lighting system, both distributed from the same central station. 2000 w. W Elect'n—Dec. 29, 1900. No. 38500.

Mr. Edison's Reminiscences of the First Central Station. 4800 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38718.

Recent Types of British Central Stations. Illustrates and describes the central station at West Ham, London, and features of some other English plants. 3500 w. Am Elect'n—Jan., 1901. No. 38627.

The Edison Illuminating Company's First Plant. Charles S. Bradley. An account of the plant at 257 Pearl, near Fulton street, New York. 2000 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38722.

Commutators.

The Requirements of Good Commutation. John H. Hertner. Explains the theory and practice of commutation. 2300 w. Engr, U. S. A.—Jan. 1, 1901. No. 38562.

Costs.

Electricity Supply Works Costs in 1898 and 1899. Tables and curves giving the actual and average figures of costs, etc., arrived at in analyses of accounts, in the United Kingdom. 4300 w. Elect'n, Lond—Jan. 4, 1901. No. 38749 A.

Dynamos.

Design for a 75-Light Dynamo. Cecil P. Poole. Illustrates the principal fea-

tures of a dynamo designed to maintain 75 16-c. p. incandescent lamps at 110-120 volts. 1300 w. Am Elect'n—Jan., 1901. No. 38631.

New Commutatorless Dynamo or Motor. James Asher. Aims to show how to construct a dynamo which has neither brushes, commutator nor slip rings, and which will give a perfectly steady current of high tension. 1000 w. W Elect'n—Jan. 5, 1901. No. 38664.

Starting and Stopping Direct-Current Dynamos Operated in Parallel. Alton D. Adams. Considers methods in use. 1600 w. Am Elect'n—Jan., 1901. No. 38633.

The Position of Dynamo Makers in England at the Close of 1900. Reviews the situation and considers the outlook "none too rosy" for the British manufacturers. 1500 w. Elec Rev, Lond—Dec. 28, 1900. No. 38607 A.

Generating Sets.

Direct-Connected Steam Engines and Generators. Frank C. Perkins. Compares American and foreign practice, and also gives illustrated descriptions of apparatus. 3500 w. Ir Age—Jan. 3, 1900. Serial. 1st part. No. 38486.

Generating Set of 800 Kilowatts (Groupe Electrogène de 800 Kilowatts). A. Boudon. Illustrated description of the combined set of compound Corliss engines by Bollinckx, and alternator of the Société Electricité et Hydraulique exhibited at Paris. 2000 w. 1 plate. Génie Civil—Dec. 22, 1900. No. 38903 D.

Generating Set of 1000 Kilowatts (Groupe Electrogène de 1000 Kilowatts). A. Boudon. A description of the Van den Kerchove engine and alternator by the Compagnie Internationale d'Electricité de Liège, exhibited at Paris. 1000 w. 1 plate. Génie Civil—Jan. 12, 1901. No. 38908 D.

Generating Set of 330 Kilowatts (Groupe Electrogène de 330 Kilowatts). G. Henry. An illustrated description of the compound engine by Stork Bros., and continuous-current generator by the Elektrotechnischer Industrie, exhibited at Paris. 1500 w. 1 plate. Génie Civil—Dec. 29, 1900. No. 38905 D.

Generating Set of 1,250 Horse-Power (Groupe Electrogène de 1,250 Chevaux). A. Morizot. Describing the Delaunay-Belleville engine and Breguet alternator, exhibited at Paris. 2500 w. Revue Technique—Dec. 25, 1900. No. 38910 D.

The 3,000 Kilowatt Dynamos of the Berlin Electric Station (Die 3,000 Kw. Dynamos der Berliner Elektrizitäts-Werke). Giving details of these fine new examples of alternators built by the Allgemeine-Elektrizitäts-Gesellschaft, and of the triple-expansion engines by which they are driven. 2000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Jan. 5, 1901. No. 38925 D.

Isolated Plant.

The Electric Light and Power Plant of the Saxon Machine Works (Die Elektrische Kraft und Lichtanlage der Sächsischen Maschinen Fabrik). W. Philippi. A general description of a large isolated plant in a manufacturing establishment at Chemnitz, Saxony. 6000 w. *Elektrotech Zeitschr*—Jan. 3, 1901. No. 38961 B.

Load Tests.

Water Loads for Electricity Works. W. E. Warrilow. Illustrates and describes a "home-made" resistance, constructed at small cost, that has proved useful and satisfactory. 1500 w. *Elec Rev, Lond*—Dec. 28, 1900. No. 38606 A.

Montana.

Notes on Electric Light and Power Work at Butte, Mont. J. R. Cravath. Illustrates and describes the water-power plant of the Montana Power Transmission Co., on the Big Hole River, 20 miles from Butte, the transmission line, and the steam plant at the sub-station in Butte. 1500 w. *Elec Wld & Engr*—Jan. 26, 1901. No. 38880.

Parallel Running.

Parallel Running for Central Stations. L. R. Lee. Considers three methods of parallel running and the conditions under which each may prove satisfactory. 2200 w. *Elec Rev, Lond*—Jan. 4, 1901. No. 38702 A.

Polyphase Plant.

New Polyphase Plant of the Commonwealth Electric Company. Illustrated detailed description of a new station on the South Side of Chicago. 5000 w. *W Elect'n*—Jan. 12, 1901. No. 38824.

LIGHTING.**Arc Lamps.**

One Method Dealing with the High Voltage Arc Lamp Trouble. J. G. Griffin. Describes a method that proved successful. 1800 w. *Elec Rev, Lond*—Jan. 4, 1901. No. 38703 A.

Some Early Arc Lighting Experiences. George W. Stockly. 1000 w. *Elec Rev, N. Y.*—Jan. 12, 1901. No. 38719.

Chicago.

Chicago's Lighting Plant: Its Progress Under Municipal Ownership. Edward R. Ellicott. From a paper read before the League of Am. Munic. Favors municipal ownership, and claims the city is saved \$160,400 annually. 1400 w. *Munic Engng*—Jan., 1901. No. 38485 C.

Coast Lighting.

Electric Lights Along the Coast. George E. Walsh. An account of the recent application of electricity to a large number of lighthouses, lightships and signal lights. 1400 w. *Elec Wld & Engr*—Dec. 29, 1900. No. 38498.

Cold Light.

Light Without Heat. R. A. Fessenden. Discusses methods of lighting, and concludes that in chemical methods the solution of the problem is most likely to be found. 3600 w. *Elec Wld & Engr*—Jan. 5, 1901. No. 38671.

Crookes Tubes.

Observations on Crookes Tubes. H. Westbury. Read at New York City, before the Roentgen Soc. of the U. S. 2200 w. *W Elect'n*—Jan. 5, 1901. No. 38665.

Development.

The Electric Light. Richard H. Pierce. Brief review of the development. Ill. 2200 w. *W Elect'n*—Jan. 5, 1901. No. 38662.

Illumination.

Electric Lighting. Dugald C. Jackson. Calls attention to the great waste in producing the electric light, and the need of correction. 1000 w. *Elec Wld & Engr*—Jan. 5, 1901. No. 38675.

Incandescence.

The Behavior of Incandescent Electrolytic Bodies (Einiges über das Verhalten Elektrolytischer Glühkörper). W. Nernst and W. Wild. With especial reference to material for the incandescent rod for the Nernst lamp. 1800 w. *Zeitschr f Elektrochemie*—Dec. 20, 1900. No. 38972 G.

Infirmary.

The Electric Lighting of the Liverpool Royal Infirmary. E. S. Bradburne. Illustrated description of an interesting installation where many precautions were necessary. 1000 w. *Elec Engr, Lond*—Jan. 18, 1901. No. 39030 A.

Modern Plant.

Modern Electric Lighting Plant. R. D. Summerfield. A short description of electric lighting machinery as used at the present day, including boilers, engines, generators, and all auxiliary plant connected with them. 2200 w. *Elec Engr, Lond*—Jan. 18, 1901. Serial. 1st part. No. 39031 A.

Nottingham.

Nottingham Corporation Electric Lighting and Tramways. Illustrated detailed description of interesting features of the improved plant. 3300 w. *Elec Rev, Lond*—Jan 11, 1901. No. 38800 A.

Paris Exposition.

Report on Electric Lighting Exhibits at the Paris Exposition. An advance copy of the official report of Carl Hering in his capacity as U. S. Juror for Class 25. 4500 w. *Elec Wld & Engr*—Dec. 29, 1900. No. 38496.

Review.

A Review of the History of Electric Lighting. Edwin R. Weeks. 3800 w. *Elec Rev, N. Y.*—Jan. 12, 1901. No. 38720.

Train Lighting.

Electric Lighting for Railway Cars in Germany. A railway accident has caused an investigation into the danger of illumination by gas, and the advantages of electric lighting. 1100 w. U. S. Cons Repts, No. 929—Jan. 8, 1901. No. 38561 D.

The Electric Lighting of Railway Carriages (Die Einführung Elektrischer Beleuchtung des Eisenbahnwagen). A very full discussion before the German Electro-technical Society, by Dr. Buttner and others. 15000 w. Elektrotech Zeitschr—Jan. 3, 1901. No. 38963 B.

MEASUREMENT.**Charges.**

The Wright Current Tariff System (Das Wright'sche Stromtariffsystem). Edmund Hohmann. Giving formulas and a description of a maximum consumption meter upon which charges for electricity supply may be based. 4000 w. Elektrotech Zeitschr—Jan. 17, 1901. No. 38966 B.

Potentiometer.

The Carpentier Potentiometer (Potentiometre J. Carpentier). M. Aliamet. Describing an improved form of the Thomson-Varley bridge for accurate electrical measurements. 1800 w. L'Electricien—Jan. 5, 1901. No. 38970 B.

Temperatures.

Electrical Measurement of Furnace Temperatures. Leonard Waldo. Describes methods used. 1700 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38726.

POWER APPLICATIONS.**Agricultural Experiment.**

An Electrically Moved Grazing Pen. A. D. McNair. Describes the application of electricity for the slow moving of a bottomless pen over the grazing field, thus avoiding the tramping of the alfalfa. Ill. 1400 w. Elec Wld & Engr—Jan. 19, 1901. No. 38816.

Crane.

Electric Traveling Crane of 20 Tons Capacity (Pont Roulant Electrique de 20 Tonnes). Illustrated description of 5-motor crane built by Ganz & Co., of Budapest, and exhibited at Paris. There are two trolleys, and three-phase motors are used. 1 plate. 1200 w. Génie Civil—Dec. 15, 1900. No. 38901 D.

Electric Driving.

Electrically Operated Machine Tools. Frank C. Perkins. States the advantages and describes American and foreign practice, illustrating various applications. 2800 w. Mod Mach—Jan., 1901. No. 38553.

Electric Power Machinery in Iron and

Steel Works. S. F. Walker. Giving many examples of the practical applications of electric driving in effecting economies in the production of the prime materials of construction. 3500 w. Engineering Magazine—Feb., 1901. No. 38977 B.

The Computation of Resistances, Motors, and Other Details of Electric Driving (Die Berechnung von Widerständen, Motoren und Dergleichen für Aussetzende Betriebe). E. Oelschläger. Giving graphical and analytical methods of computing the various parts of a power system for given conditions. 5000 w. Elektrotech Zeitschr—Dec. 20, 1900. No. 38957 B.

The Electric Distribution of Power in Workshops. Discussion by F. B. Crocker, Gano S. Dunn, W. H. Tapley, and others. Ill. 7800 w. Jour Fr Inst—Jan., 1901. No. 38656 D.

Electric Power.

See Mining and Metallurgy, Mining.

Equipment.

Electrical Equipment of the South-Eastern and Chatham Railway Co.'s Locomotive Sheds at Slade's Green. An illustrated description of a modern plant furnishing electricity for light and power. 2500 w. Elect'n, Lond—Dec. 21, 1900. No. 38468 A.

Gun Equipment.

Electrical Equipment of High Power Guns. Grahame H. Powell. Illustrates and describes the equipment of large-caliber guns. 1100 w. Elec Wld & Engr—Jan. 19, 1901. No. 38815.

Hoists.

Some Recent Tests on Electrically-Driven Hoists. Reports a series of tests made upon two hoists, considering the faults observed to be due, not to the use of electricity, but to the application. Ill. 3000 w. Elec Rev, Lond—Dec. 28, 1900. No. 38608 A.

Polyphase.

Non-Synchronous Polyphase Motor of 600 H. P. and 75 Revolutions (Asynchroner Drehstrommotor von 600 P. S. mit 75 Umdrehungen). A description of a large polyphase motor recently constructed by the Oerlikon works. 1200 w. Schweizerische Bauzeitung—Dec. 29, 1900. No. 38939 B.

Rock Drill.

An Improved Electric Rock Drill (Ueber eine Neue Elektrische Gesteinsbohrmaschine). W. Meissner. An illustrated description of the Lange-Fromholt machine, as made by Siemens & Halske. 2500 w. Glückauf—Dec. 22, 1900. No. 38955 B.

War Services.

The Electrical Engineers R. E. in South Africa. R. E. Crompton. Lecture before the Inst. of Elec. Eng., England. An illustrated account of the war services of the English volunteers. 5600 w. Elect'n, Lond—Dec. 28, 1900. No. 38600 A.

TRANSMISSION.**History.**

I. The History of Power Transmission. II. Electric Power Transmission To-Day and To-Morrow. The first article reviews the development. The second, by L. B. Stillwell, considers the present state of this art, and the outlook. 1200 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38725.

Long-Distance.

Power Transmission. Alton D. Adams. On the development of the gas engine in connection with the problems of long-distance power transmission. 3000 w. Min & Sci Pr—Jan. 5, 1901. No. 38688.

Power Transmission.

Electrical Compared with Mechanical Transmission in Factories. H. H. Holding. A comparison, showing that electrical transmission has many advantages. 1400 w. Engr, U. S. A.—Jan. 1, 1901. No. 38563.

Review.

Electrical Power Transmission. Dr. Louis Bell. Reviews the development and remarks its steady progress without failures. 2600 w. Elec Wld & Engr—Jan. 5, 1901. No. 38673.

MISCELLANY.**Outlook.**

Electricity in the Coming Century.

Elihu Thomson. Reviews the problems awaiting solution, and the probable fields where research will be rewarded. 2000 w. Elec Wld & Engr—Jan. 5, 1901. No. 38668.

Rates.

The Rate Question. Henry L. Doherty. Read at the Milwaukee meeting of the Northwestern Elec. Assn. Describes the system advocated by the writer, and gives his reasons for objecting to the usual methods of charging. 1800 w. Elec Rev, N. Y.—Jan. 26, 1901. No. 38878.

Review.

A Century of Electrical Progress. E. E. Fournier d'Albe. An illustrated review. 3700 w. W Elect'n—Jan. 5, 1901. No. 38660.

Electrical Engineering. Editorial review of the present standing in Great Britain, and of the work accomplished. 3800 w. Engr, Lond—Jan. 4, 1901. No. 38741 A.

Electricity in the Nineteenth and Twentieth Centuries. A. E. Kennelly. Reviews the progress made in the century just closed, and discusses where improvements are looked for in the coming century. 4400 w. Am Elect'n—Jan., 1901. No. 38628.

One Hundred Years of Electrical Industry and Finance. T. C. Martin. A review of the remarkable progress of an industry now representing an investment of nearly four billions. 2500 w. Elec Wld & Engr—Jan. 5, 1901. No. 38682.

The First Century of Electricity. Charles T. Child. An interesting review of the progress and achievements of the last hundred years. 9500 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38713.

GAS ENGINEERING**GAS ENGINEERING.****Accounting.**

Book-keeping for Gas-Works. Charles Sandell. The first of a series of articles from a writer of large experience. 3000 w. Gas Wld—Jan. 19, 1901. Serial. 1st part. No. 39029 A.

Calcium Carbide.

Some New Uses for Calcium Carbide. Describes the processes of preparing the carbon, and states uses for the destruction of mildew and phylloxera in vines. 1500 w. Engr, Lond—Jan. 18, 1901. No. 39036 A.

Coal Tar.

The Present Condition of the Coal-Tar Industry. H. W. Jayne. Address at meeting of the Philadelphia Soc. of the Am. Chem. Soc. Reviews the growth of this industry and its present importance. 3000 w. Sci Am Sup—Jan. 5, 1901. No. 38536.

Consumption.

The Effect of Quality of Gas on Consumption. John T. Sheard. A criticism of Mr. Dibdin's paper on this subject. 3500 w. Gas Wld—Jan. 19, 1901. No. 39028 A.

Court Decision.

Text of the Decisions by the Court of Appeals, State of Kentucky, in the Matter of the Status of the Kentucky Heating Company to the Gas Supply of Louisville. 3300 w. Am Gas Lgt Jour—Jan. 7, 1901. No. 38589.

Gas Producer.

Producer-Gas and Its Application. F. J. Rowan. Part first is introductory to the subject. 900 w. Ir & Coal Trds Rev—Jan. 18, 1901. Serial. 1st part. No. 39051 A.

The Morgan Continuous Gas Producer. Gives tabulated results of tests made, and

information regarding the producer. Ill. 1500 w. *Ir Age*—Jan. 17, 1901. No. 38753.

High-Pressure.

High Pressure Gas for Incandescent Lighting. A. W. Onslow. Gives an account of tests, describing apparatus and methods used, and an estimate of cost. Ill. 2000 w. *Gas Eng's Mag*—Jan. 10, 1901. No. 39027 A.

Illumination.

Hygienic Artificial Illumination. L. A. W. Alleman. Read before the Med. Soc. of the County of Kings, and published in the *Brooklyn Medical Journal*. The present article considers the sources of light, the chandelier, light saved by the use of reflectors, etc. 3200 w. *Pro Age*—Jan. 1, 1901. Serial. 1st part. No. 38507.

Impure Air.

Vitiation of Air on Gas Works. R. Gordon Mackay. On the harmlessness of the air in gas-works, and precautions taken to rid the air of dust. 1500 w. *Jour Gas Lgt*—Jan. 1, 1901. No. 38710 A.

Incandescence.

Prof. V. B. Lewes and the De Lerv Light. W. H. Birchmore. A criticism of statements made by Mr. Lewes in relation to the incandescent illumination system known as that of De Lery. 4400 w. *Am Gas Lgt Jour*—Dec. 31, 1900. No. 38499.

Loss.

In What Manner Can the Normal Loss of Gas in Distribution Be Most Largely Diminished? M. P. H. Gibbons. Read before the Paris Gas Congress. Mentions places where leaks are most likely to occur, and the precautions that should be taken. 3500 w. *Gas Eng's Mag*—Dec. 10, 1900. No. 38466 A.

Meters.

Meter Testing at the Works and Elsewhere. Part first considers methods of testing and gives an illustrated description of the Parkinson test gasholder. 1600 w. *Gas Engineers' Mag*—Jan. 10, 1901. Serial. 1st part. No. 39026 A.

Ownership.

Municipal Ownership. Edward Webster

Bemis. Testimony presented before the U. S. Industrial Commission. 6000 w. *Pro Age*—Jan. 15, 1901. No. 38754.

Production.

Coal Gas and Water Gas. Alton D. Adams. Describes how each is produced and compares the several processes of gas production. 2400 w. *Munic Engng*—Jan., 1901. No. 38482 C.

Regenerator.

The Working of Regenerator Furnaces. S. B. Chandley. Read before the Manchester and District Junior Gas Assn., England. Concerning the construction, general arrangement and working of regenerative settings. 5400 w. *Am Gas Lgt Jour*—Jan. 14, 1901. No. 38691.

Supply.

Gas Supply. Editorial review of the progress during the century and especially during the last year. 1200 w. *Engr, Lond*—Jan. 4, 1901. No. 38744 A.

Switzerland.

The Development of the Swiss Gas Works in the Past 20 Years (*Die Entwicklung der Schweizerischen Gaswerke in den Letzten Zwanzig Jahren*). With diagrams showing the relative progress of Swiss cities. 1000 w. *Schweizerische Bauzeitung*—Dec. 29, 1900. No. 38940 B.

Water-Gas.

The Manufacture of Water-Gas at the Forty-fourth Street Station, New York. An illustrated description of the plant and its operation. 2000 w. *Sci Am*—Jan. 19, 1901. No. 38757.

Theory of the Water-Gas Process. H. Strache and R. Jahoda. Abstract translation of articles published in the *Journal für Gasbeleuchtung*. 3000 w. *Jour Gas Lgt*—Jan. 1, 1901. Serial. 1st part. No. 38711 A.

Zurich.

The New Gas Works at Schlieren, Zurich. A translation, with illustrations, of Herr Weiss's description of these works, which present many interesting constructional details. 2 plates. 5700 w. *Jour Gas Lgt*—Jan. 1, 1901. Serial. 1st part. No. 38709 A.

MARINE AND NAVAL ENGINEERING

Armour Plates.

See Metallurgy, Iron and Steel.

Battleships.

German Battleship, "Wittelsbach." Criticism of the German type, and particulars of the vessel named. Ill. 1800 w. *Engr, Lond*—Dec. 28, 1900. No. 38622 A.

Boilers.

The Marine Steam Boiler. William Frederick Durand. An elementary discussion of the principles controlling the generation of steam. 1600 w. *Marine Engng*—Jan., 1901. No. 38695 C.

Compass.

New Design for Compass Card. A

proposition to do away with compass points, and to use a card graduated in a circle of degrees continuously to the right. Ill. 1000 w. Marine Rev—Jan. 10, 1901. No. 38690.

Destroyers.

The Propelling Machinery of a Torpedo-Boat Destroyer. William David Seton Brown. Read at meeting of the Newcastle Assn. of Students of the Inst. of Civ. Engrs. Discusses the machinery of this class of vessels and the improvements needed. 2500 w. Prac Engr—Dec. 28, 1900. Serial. 1st part. No. 38602 A.

French Navy.

The French Navy. Summary from *Le Yacht*, with comments. 1400 w. Engr. Lond—Jan. 18, 1901. No. 39034 A.

Launch.

A Bullock Electric Launch. Illustrated description of a boat representing the latest practice in electric propulsion for small pleasure craft. 700 w. Marine Engng—Jan., 1901. No. 38694 C.

Life Saving.

Life-Saving Appliances at the Paris Exhibition. Review of the exhibits in competition for the Anthony Pollok prize. Ill. 3800 w. Engr. Lond—Jan. 4, 1901. No. 38735 A.

Light Draught.

The "Sayhueque," a Light Draught Steamer. Illustrated description of the first of three vessels ordered for the Argentine Government, for cargo and passenger service on the Rio Negro. 800 w. Engng—Jan. 4, 1901. No. 38731 A.

Liner.

Magnificent New Liner. Illustration and detailed description of the "Vaderland" of the New York and Antwerp Line. 2700 w. Naut Gaz—Dec. 27, 1900. No. 38503.

New Transatlantic Liner "Vaderland" for the Red Star Line. Illustration, with description of the vessel and its equipment. 2000 w. Marine Engng—Jan., 1901. No. 38692 C.

Liquid Fuel.

Liquid Fuel Burning Steamer "Bulyses." Illustration and description of a tank steamer of nearly 8,500 tons, and the appliances for burning the liquid fuel. 1000 w. Engng—Dec. 28, 1900. No. 38612 A.

Marine Engines.

Engines and Boilers of the "Inchdune" and "Inchmarlo." Illustrated description of marine machinery, of interest because of the construction and the highly economical results obtained. 2200 w. Engng—Jan. 18, 1901. No. 39041 A.

The Marine Engineer. Howard Pat-

erson. Discusses his present opportunities and prospects. 1300 w. Naut Gaz—Dec. 27, 1900. No. 38505.

Merchant Marine.

Merchant Marine of France. Résumé of a report made by Mr. Thierry, Deputy from Marseilles, in the name of the budget committee of 1900 of the Chamber of Deputies. 3300 w. U. S. Cons Repts, No. 927—Jan. 5, 1900. No. 38520 D.

The Progress of the Continental Merchant Marine. Information concerning various continental shipyards, and the work in progress. 3000 w. Engr. Lond—Dec. 28, 1900. No. 38620 A.

Naval Power.

The Engineering Crisis in the Navy. D. B. Morison. Read before the Inst. of Engrs. and Shipbuilders in Scotland. A supplementary paper to one read last March on "The British Naval Engineer." Calls attention to recent developments, and the broader aspects of the question. 3500 w. Engng—Jan. 4, 1901. Serial. 1st part. No. 38733 A.

Repairs.

Emergency Repairs of Electrical Machinery on Board Ship. William Baxter, Jr. Considers expedients that may be resorted to temporarily, until port is reached. 2100 w. Marine Engng—Jan., 1901. Serial. 1st part. No. 38696 C.

Shipbuilding.

New Vessels Under Construction. A record of the craft under construction in United States shipyards. 7000 w. Naut Gaz—Jan. 10, 1901. No. 38687.

Shipbuilding and Marine Engineering in 1900. A review of the statistics of this industry in the United Kingdom. 3500 w. Engng—Jan. 4, 1901. Serial. 1st part. No. 38730 A.

Shipbuilding in the United States During the Past Year. A review of this industry, with a list of all steam vessels, sailing vessels, and sea-going barges of over 500 tons which have been launched in the United States during the past year. Ill. 9500 w. Naut Gaz—Jan. 3, 1901. No. 38507.

The Development of British and German Shipbuilding (Einiges aus der Entwicklung des Deutschen und des Englischen Schiffbaus). With comparative outlines of many vessels, and diagrams of dimensions and performances. 3000 w. Glaser's Annalen—Dec. 15, 1900. No. 38928 D.

Ship Heating.

The Ventilation and Heating of Ships by a Forced Circulation of Warm Air. F. W. Jennings. Abstract of a paper read before the N. E. Coast Inst. of Engrs. and Shipbuilders. An illustrated description of the plenum system. 2500 w. Engrs' Gaz—Jan., 1901. No. 38705 A.

Shipping Bill.

Revival of American Shipping. Marcus A. Hanna, in the *National Magazine*. How the bill now before the U. S. Congress proposes to bring about a return of the over-sea trade in American vessels. 3000 w. *Marine Rev*—Jan. 24, 1901. No. 39024.

Ship Telegraph.

See Electrical Engineering. Communication.

Shipyard.

Great Virginia Shipyard. Illustrated description of the plant of the William R. Trigg Company, at Richmond, Va. 1500 w. *Naut Gaz*—Jan. 17, 1901. No. 38775.

Steamships.

Mammoth Steamships. Illustration, with description of the new Hill passenger and freight boats, the largest craft ever built. They are intended for trans-Pacific trade, and will be 21,000 tons gross register, costing \$2,500,000 each. The product of an American shipyard. 1400 w. *Naut Gaz*—Jan. 10, 1901. No. 38686.

Steamship Performance. Comments on the performance of steamships hired as transports, and the inability of a vessel designed for a special voyage to maintain the same qualities for a totally different passage. 1200 w. *Engr, Lond*—Jan. 11, 1901. No. 38807 A.

Submarine.

The Admiralty and Submarine Boats. Edmund Robertson. On the attitude of the British Admiralty, and also comment on what has been done in France and the

United States. 4400 w. *Nineteenth Cent*—Jan., 1901. No. 38793 D.

The Development and Future Possibilities of the Submarine Boat. Editorial criticism of statements made by John P. Holland, the inventor of the Holland submarine boat. 2500 w. *Eng News*—Jan. 10, 1901. No. 38649.

The French Submarine Boats. The latest information concerning these boats, with editorial discussion. 4000 w. *Engr, Lond*—Jan. 18, 1901. No. 39033 A.

Subsidies.

Substitutes for Ship Subsidies. Louis Windmüller. A discussion of the subsidy bill before the U. S. Congress, claiming it will not accomplish its avowed objects, and offering suggestions. 3000 w. *N Am Rev*—Jan., 1901. No. 38519 D.

Turbine.

Turbine Propulsion for a New Clyde Passenger Steamer. An account of a vessel to do service between Fairlie and Campbeltown. 1200 w. *Engr, Lond*—Jan. 11, 1901. No. 38811 A.

Twin-Screw Boat.

Twin-Screw Combined Fire, Tug, and Police Boat. Illustrates and describes a seaworthy vessel built for the Mexican Government. 900 w. *Engng*—Jan. 11, 1901. No. 38834 A.

Warships.

Progress of Warships and Machinery Building in England. Supplementary to an article published June 29. The present article gives a résumé of progress during the latter half of the expiring year. 3500 w. *Engr, Lond*—Dec. 28, 1900. No. 38618 A.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Automobile Station.

The New Station of the New York Electric Vehicle Transportation Company. R. A. Fliess. Reviews the history of this company, and begins an illustrated description of the building. 5700 w. *Elec Wld & Engr*—Jan. 5, 1901. Serial. 1st part. No. 38666.

Berlin Trials.

The Berlin Electromobile Trials. Gives the chief results of the 14 vehicles tested by Dr. M. Kallmann, with their leading characteristics. 1000 w. *Auto Jour*—Jan., 1901. No. 39008 A.

Business Vehicles.

Early Developments. William H. Maxwell, Jr. Showing the practicability of the commercial vehicle, and that it is cheaper than the horse. Illustrates three

trucks. 3000 w. *Auto Mag*—Jan., 1901. No. 38478 C.

The Motor Wagon for Business and a New Power Transmission Device. A. H. Chadbourne. Discusses the requirements of the successful motor wagon, and describes some new devices. Ill. 2500 w. *Auto Mag*—Jan., 1901. No. 38479 C.

Delivery Wagons.

The Electric Delivery Equipment of a Large New York Store. Max Loewenthal. An illustrated account of the automobile delivery service of B. Altman & Co. 3200 w. *Elec Wld & Engr*—Dec. 29, 1900. No. 38495.

Design.

Electric Vehicle Design. H. M. Underwood. Discusses the defects in construction, and illustrates and describes the omnibus of the Hewett-Lindstrom Motor

Co. 1800 w. Auto Mag—Jan., 1901. No. 38480 C.

Motor Vehicles.

Electric Automobiles. Henry F. Joel. Gives a brief criticism of the early attempts to produce successful electric carriages, outlining the defects that caused failures, and predicting future success. 4900 w. Elec Rev, Lond—Jan. 4, 1901. No. 38699 A.

Electromobile Evolution. W. H. Maxwell, Jr. What has been accomplished in this field, and the outlook. 3500 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38716.

The Automobile. Harold H. Eames. Considers the future of this industry more likely to be determined by commercial considerations than by any mechanical advance. 4500 w. Elec Wld & Engr—Jan. 5, 1901. No. 38679.

Steam Vehicle.

The Musker Steam Wagon. Illustrates and describes an English vehicle, aiming at automatic control, and having the machinery carried on a separate under frame. 3000 w. Auto Jour—Jan., 1901. No. 39007 A.

Tyres.

Elastic Tires for Wheels (Bandages Elastiques pour Roues). Leo Dex. A general discussion of pneumatic and cushion tires, with reference to an improved form of cellular tire. 2000 w. Revue Technique—Dec. 25, 1900. No. 38912 D.

Report on Elastic Tires. M. Michelin. Presented at the International Automobile Congress. Reviews the history of tires, properties of elastic tires, experiments made, etc. 4800 w. Horseless Age—Jan. 2, 1901. No. 38524.

Washington, D. C.

The Washington, D. C., Electric Automobile Service. Illustrated description of the fine plant. 1700 w. Elec Wld & Engr—Jan. 26, 1901. No. 38881.

HYDRAULICS.

Hydraulic Power.

Hydraulic Power Plant, Montmorency Falls, Canada. George W. Bowie. An illustrated detailed description of the power and generating station of the Quebec Railway, Light and Power Co. 2800 w. Engr, Lond—Jan. 11, 1901. No. 38810 A.

Practical Notes on Water Power for Electrical Purposes. F. R. Yorke. Read before the Glasgow Sec. of the Inst. of Elec. Eng. Discusses some of the principal types of plant used in Gt. Britain, indicating the conditions for which they are suited, and dealing with practical de-

tails. 4000 w. Elect'n, Lond—Jan. 11, 1901. No. 38846 A.

Pumps.

Hydraulically-Driven Pumps (Hydraulisch Betriebene Wasserhaltungsmaschinen). Fr. Frölich. Describing the use of hydraulic motors for operating mine pumps, with especial reference to the Kaselowsky system. 3500 w. Zeitschr d Ver Deutscher Ing—Dec. 15, 1900. No. 38916 D.

Modern Pumping Machinery (Neuer Pumpmaschinen). G. ter Meer. Especially discussing improved forms of Riedler express-pumps driven direct by electric motors. Two articles, 10000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Jan. 5, 12, 1901. No. 38924 each D.

The Riedler Express Pumps (Les Pompes Express Riedler). M. Rony. With especial reference to high-speed electrically driven pumps with the Riedler mechanically moved valves. 2500 w. Revue de Mécanique—Dec. 31, 1900. No. 38945 H.

Siphon.

A Successful Siphon. Robert S. Hale. Describes the solution of a problem for supplying water to Schooner Head, Bar Harbor, Me. Used an air-tight siphon at a cost of about \$250. Ill. 1500 w. Jour Assn of Engng Socs—Nov., 1900. No. 38636 C.

MACHINE WORKS AND FOUNDRIES.

Air Hammer.

Experiments on an Air Hammer (Versuche mit einem Lufthammer). Prof. A. Lüdicke. A report upon researches made with the indicator and dynamometer upon an Arns pneumatic hammer, used for rivetting railway tires upon the wheels. 2000 w. Zeitschr d Ver Deutscher Ing—Dec. 29, 1900. No. 38921 D.

Boiler-Making.

Belleville Boiler-Making Machinery. Illustrated description of special machine tools. 800 w. Engr, Lond—Dec. 28, 1900. No. 38621 A.

Boring.

Mechanism for Boring Elliptical Cylinders. C. W. MacCord. Showing how an elliptical cylinder of any length can be finished inside by the use of an ordinary boring bar, turning in fixed bearings with uniform velocity. 1200 w. Stevens Ind—Jan., 1901. No. 38888 D.

Brakes.

Band Brakes. C. F. Blake. A diagram with directions for obtaining their proportions. 1200 w. Mach, N. Y.—Jan., 1901. No. 38533.

Brass Foundry.

Fitting Up a Brass Foundry. C. Vickers. Considers the internal arrangements

of a brass foundry. 1600 w. Am Mach—Jan. 17, 1901. No. 38776.

Bridge Shop.

Construction and Equipment of a Bridge Shop Plant. Illustrated description of works, having numerous novel methods of handling tools and work; using electric power transmission. 1600 w. Eng Rec—Jan. 5, 1901. No. 38568.

Cast Iron.

Characteristics of the Chemical and Physical Properties of Cast Iron. Thomas D. West. A lecture delivered before Sibley College. Shows the utility of chemical analyses, and discusses the effects of treatment and composition. Ill. 4000 w. Sib Jour of Engng—Jan., 1901. Serial. 1st part. No. 38837 C.

Crane.

See Electrical Engineering. Power Applications.

Dies.

A Novel and Ingenious Cutting and Bending Die. George W. Freeman. Illustrated description of the making of the die and its operation. 500 w. Am Mach—Jan. 24, 1901. No. 38865.

Dies for Drawing Wire: Their Manufacture and Use. William D. Pierson. Information concerning materials used for dies, and the methods of wire drawing. 900 w. Stevens Ind—Jan., 1901. No. 38887 D.

Electric Driving.

See Electrical Engineering. Power Applications.

Foundry Appliances.

Pneumatic Tools and Appliances in Foundry Service. W. P. Pressinger. Reviews briefly the various appliances which have lightened labor and reduced costs, that are dependent upon compressed air for their power. Ill. 2500 w. Jour Am Found Assn—Jan., 1901. No. 38521 C.

Hoists.

See Electrical Engineering. Power Applications.

Interchangeable Parts.

Manufacture by the System of Interchangeable Parts. E. G. Parkhurst. Describes old methods of work, and the systems in use in the United States and Germany, and gives information of interest. Ill. 4300 w. Am Mach—Jan. 3, 1901. No. 38544.

Krupp.

The Krupp Works in 1900 (Les Etablissements Krupp en 1900). G. Bresson. A review of the development of the Krupp works up to the time of the Exposition of 1900, with statistics of production, etc. 1200 w. Génie Civil—Dec. 22, 1900. No. 38904 D.

Laboratory.

A Practical Laboratory. Illustrated description of the laboratory of the J. I. Case Threshing Machine Co., Racine, Wis. 2300 w. Ir Age—Jan. 24, 1901. No. 38843.

Labour Remuneration.

The Application of Piece-Work and the Premium Plan. Sir B. C. Browne. A discussion of the importance and relative fields of the premium and piece-work systems from a British view-point. 3000 w. Engineering Magazine—Feb., 1901. No. 38981 B.

Machine Tools.

The Early Machine Tools of Henry Maudslay. W. A. S. Benson. An illustrated historical sketch of the products of an old English firm. 3000 w. Engng—Jan. 18, 1901. Serial. 1st part. No. 39039 A.

Molding.

Machine Molding. I. L. McCord. Read at a meeting of the Foundrymen's Assn. Considers the application of molding machines to foundry work, the saving in cost, the various machines, etc. 4500 w. Foundry—Jan., 1901. No. 38525.

Organization.

The Organization of the Factory Sales Department. O. D. Hogue. A discussion of the most effective means toward trade extension and prosperity in manufacturing industries. 2500 w. Engineering Magazine—Feb., 1901. No. 38976 B.

Paper-Making.

Paper-Making Machinery at the Paris Exhibition. Illustrated description of a few of the exhibits, seen in actual working. 1700 w. Engng—Jan. 18, 1900. Serial. 1st part. No. 39043 A.

Punching.

Drawing and Punching Continuous Strips of Half Balls. Joseph V. Woodworth. Illustrates the punch and die used, and describes the work. 900 w. Am Mach—Jan. 24, 1901. No. 38863.

Punch Press.

A Special Punch Press. Joseph V. Woodworth. Illustrated detailed description. 1600 w. Am Mach—Jan. 3, 1901. No. 38546.

Shop Lighting.

Experiments on the Diffusion of Light Through Prismatic and Ribbed Glass Windows. Abstract of the conclusions of a report made by Charles L. Norton, on a series of tests conducted for the Associated Factory Mutual Companies of New England. 1500 w. Eng News—Jan. 10, 1901. No. 38651.

Shops.

The New Shops of the Woodward &

Powell Planer Co., Worcester, Mass. Illustrated description of the shops, system used, methods of manufacture, etc. 2800 w. Mach, N. Y.—Jan., 1901. No. 38532.

Squares.

The Making of a Real Square. Theodore H. Miller. Illustrates and describes a square made for very accurate work, and the manner of testing. 3000 w. Am Mach—Jan. 3, 1901. No. 38545.

Steel Works.

The Granite City Plant of the National Enameling and Stamping Company. Illustrated detailed description of a plant designed for a special product of open-hearth steel suitable for enameling, and for making granite ware. 3000 w. Ir Age—Jan. 10, 1901. No. 38596.

Welding.

The Metallurgical Uses of Aluminum. From the *Revue Industrielle*. Illustrates and describes some of the applications of the properties of aluminum as utilized in the Goldschmidt process. 4000 w. Sci Am Sup—Jan. 5, 1901. No. 38535.

The Process of Aluminothermy (L'Industria Allumino-Termica). Giorgio Levy. An illustrated account of the working of the Goldschmidt process, for welding metals by the heat produced by the combustion of aluminum. 2500 w. L'Electricita—Dec. 15, 1900. No. 38971 B.

The Welding of Defective or Worn Pieces (Ausschweissen Schadhafter oder Abgenutzter Werkstücke). Dr. H. Goldschmidt. A description of the Goldschmidt process of aluminothermy for welding new journals or rolls, or making other repairs. 1000 w. Stahl und Eisen—Jan. 1, 1901. No. 38938 D.

MATERIALS OF CONSTRUCTION.

Alloys.

Mechanical and Other Treatment of Alloys of Aluminum and Magnesium. Information relating to the manipulation of magnesium alloys of aluminum. 800 w. Am Mach—Jan. 24, 1901. No. 38862.

Bronze.

Experiments Upon the Effect of Temperature on the Resistance and Ductility of Bronze (Versuche über die Abhängigkeit der Festigkeit und Dehnung der Bronze von der Temperatur). C. Bach. A very full record of experiments, with tables and diagrams. 3500 w. Zeitschr d Ver Deutscher Ing—Dec. 22, 1900. No. 38919 D.

Copper Castings.

Making Sand Castings of Copper. C. Vickers. Gives methods of making copper castings solid, and the effect of various alloys. 1200 w. Am Mach—Jan. 24, 1901. No. 38864.

Impact Tests.

Tension Impact Tests of Rolled Steel.

S. Bent Russell. Gives results of experiments made. Ill. 2000 w. Eng News—Jan. 3, 1901. No. 38551.

Low-Steel.

The Influence of Bending and Straightening Upon the Resistance of Low Steel (Einfluss des Biegens und Richtens auf die Festigkeitseigenschaften von Flusseisen). Prof. M. Rudeloff. Giving tabulated and plotted results of experiments at the Charlottenburg testing laboratory. 4000 w. Zeitschr d Ver Deutscher Ing—Jan. 12, 1901. No. 38927 D.

MEASUREMENT.

Board Measure.

Logarithmic Table of Board Measure. W. H. Sargent. Gives chart with explanation of the method of using it. 400 w. Am Mach—Jan. 24, 1901. No. 38861.

POWER AND TRANSMISSION.

Compressed Air.

A New Riedler Air Compressor. Illustrated description of a vertical engine with compound air and steam cylinders, and an unusual connection between the piston rods and fly-wheel shafts; the machine is rated at 6,860 cu. ft. of free air per minute at 80 lbs. pressure. 400 w. Eng Rec—Jan. 26, 1901. No. 39016.

Compressed Air—the Ideal Motive Power. Henry D. Cooke. Reviews the history of its application to tramways, and for other uses, and discusses the outlook. 2000 w. St Ry Rev—Jan. 15, 1901. No. 38856 C.

Multiple Stage Air Compression. John H. Barr. Read before the Cornell Soc. of Mech. Engs. Illustrates and describes single stage, two stage and three stage compression, and gives a comparison of the probable performances. 3000 w. Sib Jour of Engng—Jan., 1901. No. 38838 C.

Power.

A Combination Hydraulic and Steam Power Plant, Stuyvesant Falls, N. Y. Illustrated description of a 3,500 H. P. station for operating a third rail electric line 97 miles long, and furnishing current for power and lighting. 2100 w. Eng Rec—Jan. 5, 1901. No. 38566.

Ropeway.

Ropeway at the New Beachy Head Lighthouse. Describes the arrangement of a ropeway used in the construction of a new lighthouse, which was used not only for the transportation of materials, but of machinery and workmen. Ill. 1600 w. Engng—Jan. 11, 1901. No. 38832 A.

SPECIAL MOTORS.

Gas Engines.

New Types of Gas Engines (Les Types Nouveaux de Moteurs à Gaz). J. Deschamps. With especial reference to en-

gines of large power, used with furnace or producer gas. 2500 w. Génie Civil—Jan. 12, 1901. No. 38909 D.

The Gas Engine at the Beginning of the Twentieth Century. J. D. Lyon. A consideration of the present and future of the gas engine. 2000 w. Am Mfr—Jan. 3, 1901. No. 38581.

The Koerting Two-Cycle 350 Brake Horse-Power Gas Engine. Illustrated description of a two-cycle double-acting engine resembling a steam engine. The test gave interesting results. 1400 w. Engr, Lond—Jan. 4, 1901. No. 38745 A.

Gasoline Engine.

The Howard Gasoline Launch Engine. Herbert L. Towle. Illustrated description of the Howard marine motor, exhibited at Madison Sq. Garden, N. Y., from Nov. 3 to 10, 1900. 1300 w. Am Mach—Jan. 24, 1901. No. 38866.

STEAM ENGINEERING.

Water Motor.

Test of a New Impulse Water Motor. R. C. Carpenter. Record of tests of a twelve-inch motor, belonging to the same general class as the Pelton. 500 w. Sib Jour of Engng—Jan., 1901. No. 38839 C.

Boiler Auxiliaries.

Auxiliary Steam and Water Appliances for Water-Tube Boilers. B. H. Thwaite. Especially discussing automatic feed supply and regulation devices, separators and similar apparatus for aiding in the steady and satisfactory operation of water-tube boilers. 2500 w. Engineering Magazine—Feb., 1901. No. 38978 B.

Boiler Temperature.

Investigations Into the Temperature Relations in the Interior of a Portable Boiler (Untersuchung über die Temperaturverhältnisse im Innern eines Lokomobilkesels). C. Bach. The readings of thermometers inserted at various points are tabulated and plotted as curves, with discussion. 1200 w. Zeitschr d Ver Deutscher Ing—Jan. 5, 1901. No. 38926 D.

Boilers.

See Marine and Naval Engineering.

Chimneys.

See Architectural Engineering, Construction.

Compound Engine.

Compound Engine of 150 Horse-Power for Electric Driving (Verbunddampfmaschine von 150 Ps. für Dynamobetrieb). L. Kliment. Giving sectional drawings showing special valves, valve gear and governor. 1800 w. Zeitschr d Ver Deutscher Ing—Dec. 29, 1900. No. 38923 D.

Connecting Rods.

On the Stress Produced in a Connect-

ing Rod by Its Motion. C. H. Innes. Showing a method of arriving mathematically at the stress, and the point of greatest stress, and to give simple algebraic formulæ for calculating it for various forms of rod. 900 w. Prac Engr—Jan. 11, 1901. Serial. 1st part. No. 38831 A.

Economy.

Economy in Steam Engine Practice. John Goodman. Read at Inst. of Min. Engs., England. Considers what should be avoided, and the essential details. 2800 w. Naut Gaz—Dec. 27, 1900. No. 38504.

Fuel.

Gas Still the Cheaper Fuel. A. J. Hollis. Reports recent trials at one of the largest steel plants in the Pittsburg district to determine the relative costs of natural gas, and the best Pittsburg coal. 1000 w. Am Mfr—Jan. 3, 1901. No. 38583.

Governing.

The Design of Steam Engines with Respect of Regulation (Détermination de Certains Elements des Moteurs à Vapeur en Vue de la Régulation). M. Delaporte. Showing the influence of the dimensions of ports, steam chests, receivers, etc., upon the regulation, and deriving formulas for their proportion. 3000 w. Revue de Mécanique—Dec. 31, 1900. No. 38943 H.

The Rites Shaft Governor. Charles Buerger. Mathematical study of the equilibrium positions, and the so-called "inertia effect." 1800 w. Ill. Stevens Ind—Jan., 1901. No. 38889 D.

Heat Transmission.

The Transmission of Heat Through Heating Surfaces (Ueber den Wärmedurchgang durch Heizflächen). L. Holborn and W. Dittenberger. An account of researches conducted at the Reichsanstalt, with especial reference to boiler heating surface. 2500 w. Zeitschr d Ver Deutscher Ing—Dec. 15, 1900. No. 38917 D.

Marine Engines.

See Marine and Naval Engineering.

Progress.

A Century of Progress in Steam Engineering. A. F. Nagle. Considers the position one hundred years ago, the progress during the century, and what remains to be accomplished. 3000 w. Am Elect'n—Jan., 1901. No. 38629.

Revealer.

Theory of the Steam Engine and the Donkin Revealer (La Théorie de la Machine à Vapeur et le Révélateur Donkin). Joseph Nadal. A discussion of cylinder condensation as modified by the results obtained with the Donkin revealer. 4500 w. Revue de Mécanique—Dec. 31, 1900. No. 38944 H.

Stationary Engines.

The Evolution of the Stationary Steam Engine. Andrew Robert Robertson. From Trans. Inst. C. E. Reviews the history of the development. 5200 w. *Prac Engr*—Dec. 21, 1900. No. 38469 A.

Steam Engines.

Improvements in the Steam Engine. W. H. Wakeman. Practical problems in design and construction, installation and operation met in every day experience. Ill. 2500 w. *Mod Mach*—Jan., 1901. Serial. 1st part. No. 38555.

The Steam Engine of To-day in the Field of Electrical Engineering Practice. R. H. Thurston. A study of the progress of the later years of the nineteenth century. 6000 w. *Elec Wld & Engr*—Jan. 5, 1901. No. 38672.

Steam Heating.

See Architectural Engineering, Heating.

Steam Turbine.

Test of a Parsons Steam Turbine Driving a 1,000-Kilowatt Alternator. Illustrated abstract of a report of tests of such a unit for the city of Elberfeld, Germany, showing its economy and regulation at different loads. 1000 w. *Eng Rec*—Jan. 26, 1901. No. 39014.

Superheating.

How High Shall Steam Be Superheated (Wie Hoch Soll Dampf Ueberhitzt Werden). Josef Jedlicka. An exhaustive examination of the subject, to determine the most economical degree of superheating for given conditions. Three articles, 1 plate. 8000 w. *Oesterr Zeitschrift Berg u Hüttenwesen*—Dec. 29, 1900. No. 38952 each B.

Thermodynamics.

Elementary Graphics and Geometry of Thermodynamics. Robert H. Thurston. A graphical study of the principles of thermodynamics. 4500 w. *Jour Fr Inst*—Jan., 1901. Serial. 1st part. No. 38659 D.

MISCELLANY.**Arbitration.**

Arbitration: Its Place in Our Professional Practice. G. Alexander Wright. Read before the Tech. Soc. of the Pacific Coast, arguing in favor of arbitration as the quickest and most inexpensive process of settling vexatious disputes. 6000 w. *Jour Assn of Engng Socs*—Nov., 1900. No. 38635 C.

Arbitration of Labor Questions Necessary to Industrial Supremacy. Charles B. Going. Showing that the wastefulness of labor wars is fatal to industrial supremacy, and holding arbitration to be the only remedy. 3000 w. *Engineering Magazine*—Feb., 1901. No. 38982 B.

Industrial Arbitration. Chauncey H.

Castle. An address before the National Arbitration and Conciliation Convention. Reports the experience of the Stove Founders' National Defense Assn. 4000 w. *Ir Age*—Jan. 3, 1900. No. 38487.

Armstrong.

Lord Armstrong. Biographical sketch, with portrait, giving interesting information of his work. The Armstrong gun is described. 5300 w. *Engr, Lond*—Jan. 4, 1901. No. 38738 A.

Card Index.

The Card Index and Its Service in Machine Works (Das Kartenverzeichnis und der Anzeiger im Dienste der Maschinenfabriken). A. S. Oesterreicher. With various illustrations of the application of the card-index system to matters of record and accounting. 1800 w. *Zeitschr d Ver Deutscher Ing*—Dec. 15, 1900. No. 38918 D.

Industrial Ascendency.

Industrial Ascendency of the Anglo-American Peoples. C. L. Redfield. A discussion of the racial, educational, and territorial advantages which assure Anglo-American industrial supremacy. 3000 w. *Engineering Magazine*—Feb., 1901. No. 38975 B.

Invention.

Invention and Usage (Gebrauchsmuster und Erfindung). Dr. Scharze. A review of German patent law, showing the extent to which previous usage and the state of the art influences legislation in regard to patented inventions. 4500 w. *Zeitschr d Ver Deutscher Ing*—Dec. 22, 1900. No. 38920 D.

Machinery.

Arithmetic of Machinery. A series of practical and instructive talks to serve as evening studies for machinists, mechanics, and apprentices. Ill. 600 w. *Mod Mach*—Jan., 1901. Serial. 1st part. No. 38554.

Refrigeration.

Erecting Cold Stores in South Africa. Albert Moon. Interesting description of conditions in South Africa and the erection of a cold storage plant while war was in progress. 1600 w. *Ice & Refrig*—Jan., 1901. No. 38575 C.

Ice Making in France. Views and descriptions of an ice-making and cold storage plant at Rouen, France. American machinery and methods preferred. 700 w. *Ice & Refrig*—Jan., 1901. No. 38573 C.

Jacob Rupert's Ice Plant in New York. Illustrated detailed description of the largest ice-making plant in the world, the construction of the buildings, machinery installed, etc. 5600 w. *Ice & Refrig*—Jan., 1901. No. 38572 C.

Mexican Brewery and Ice Plant. Illus-

trated description of an ice and refrigerating plant at the Cervceria Moctezuma, Mexico. 1400 w. Ice & Refrig—Jan., 1901. No. 38574 C.

The Production of Distilled Water for Ice-Making Plants. Hal Williams. Read at meeting of the Cold Storage and Ice Assn., England. Illustrated description of apparatus used, and of the process.

3800 w. Engr. Lond—Dec. 28, 1900. No. 38623 A.

Review.

Mechanical Engineering. Editorial, calling attention to the practice of one hundred years ago and its lessons and the present standing and future outlook. 3700 w. Engr. Lond—Jan. 4, 1901. No. 38740 A.

MINING AND METALLURGY

COAL AND COKE.

Alabama.

The Warrior Coal Basin of Alabama. Henry McCalley. Its location, geological peculiarities, the thickness of the coal seams, and facilities for transportation. 2300 w. Mines & Min—Jan., 1900. No. 38475 C.

Briquettes.

Briquetting—Its Progress and Commercial Advantages. Henry S. Mould. An illustrated description of various types of the White Briquetting Press. 2200 w. Am Mfr—Jan. 17, 1901. No. 38818.

Britain.

The Coal Question in 1900. A review of its different aspects and a summary of the history of the past year in England. 3000 w. Jour Gas Lgt—Jan. 1, 1901. No. 38708 A.

Coal-Fields.

The Makum Coal-Field in Assam. George E. Harris. Abstract of a paper read before the Manchester Geol. Soc. Describes these fields in India, the deposits and collieries of this district, and the transportation facilities. 1200 w. Eng & Min Jour—Jan. 26, 1901. No. 39020.

Coal Trade.

The Lancashire Coal Trade in 1900. T. B. Wood. Reviews the output, prices and conditions affecting this industry. 2200 w. Ir & Coal Trds Rev—Dec. 28, 1900. No. 38613 A.

Crusher.

Coal Crushers (Ueber Kohlenstampvorrichtungen). Describing improved coal crushers for use in connection with coping, briquetting, and the preparation of gas coals. 2000 w. Stahl und Eisen—Dec. 15, 1900. No. 38936 D.

Cutting Machinery.

Coal-Cutting by Machinery. The first of a series of articles treating of the progress made as regards the introduction of this machinery in the United Kingdom, the difficulties and the conditions which conduce to success or failure. 2200 w.

Col Guard—Jan. 4, 1901. Serial. 1st part. No. 38747 A.

Opening-Out Coal Royalties by Machinery. Illustrates and describes the Stanley coal-heading machine used at the Nuneaton new colliery. 1100 w. Col Guard—Jan. 11, 1901. No. 38826 A.

Firedamp.

Precautions Against Firedamp at the Saint Etienne Collieries. Illustrates and describes the automatic sample-taker of mine air, invented by Paul Petit. 1500 w. Col Guard—Jan. 18, 1901. No. 39062 A.

Foreign Trade.

The Foreign Coal and Iron Trades in 1900. Briefly reviews the various European countries, in the production of these products, the prices and general conditions. 5500 w. Ir & Coal Trds Rev—Dec. 28, 1900. No. 38615 A.

French Colliery.

Bessèges Collieries at the Paris Exhibition. Describes the interesting exhibit of this colliery, the working, etc. 4600 w. Col Guard—Dec. 28, 1900. No. 38611 A.

Hungary.

Coal-Mining in Hungary. Gives the history, geology and statistics. 1100 w. Col Guard—Jan. 11, 1901. No. 38827 A.

Natal.

Coal and Iron in Natal. Information relating to these industries, the methods used, deposits, etc. 2000 w. Ir & Coal Trds Rev—Dec. 28, 1900. No. 38616 A.

Nineteenth Century.

The Nineteenth Century—Its Makers and Its Achievements. Part first deals with the progress made in coal-mining during the century. Also the handling and transportation, markets, etc., from the English point of view. 4300 w. Ir & Coal Trds Rev—Jan. 4, 1901. Serial. 1st part. No. 38697 A.

Peat.

Peat Fuel in Ontario. Describes the apparatus of the Trent Valley Peat Fuel Co. for converting the moist, spongy peat into dry, compact briquettes. 1300 w. Col Guard—Jan. 11, 1901. No. 38830 A.

Production.

Coal in 1900. An output greater than in 1899, and the increase principally from the United States. Reports from various districts. 10300 w. Eng & Min Jour—Jan. 5, 1901. No. 38594.

Raising.

A Proposed New Method to Raise Coal, etc., in Shafts. W. S. Gresley. From the Trans. of the S. Wales Inst. of Eng. Describes a scheme for slow-speed hoisting, doing away with winding, and hoisting the coal in trams, or other receptacles, without the employment of drum or rope. 1800 w. Col Guard—Dec. 28, 1900. No. 38609 A.

Saint Etienne.

The Saint-Etienne Collieries (Loire), France. Describes the exhibits made at the Paris Exhibition and gives statistics. Ill. 3000 w. Col Guard—Jan. 4, 1901. No. 38748 A.

Scotland.

The Carboniferous Limestone Coals of Scotland. R. W. Dron. Read before the Geol. Soc. of Glasgow. Descriptive. 2500 w. Col Guard—Jan. 18, 1901. No. 39053 A.

Trade.

The Coal Trade of 1900. A review of the various mining districts of Great Britain. 11800 w. Col Guard. Jan. 4, 1901. No. 38746 A.

Vancouver.

Coal Mining on Vancouver Island. R. Lind Watson. Facts in regard to the mines which have been opened and the amount and method of development. Ill. 3000 w. Miners & Min—Jan., 1901. No. 38472 C.

COPPER.**Copper.**

See Mechanical Engineering Materials.

Copper Industry.

The Lake Superior Copper Industry. Horace J. Stevens. Reviews the prosperous year of 1900. 3000 w. Ir Age—Jan. 3, 1901. No. 38492.

Extraction.

New Methods for the Extraction of Copper and Zinc. Dr. J. Ohly. Describes the process recently invented by C. G. Collins, employing the "nitre cake" and the process invented by Nicolas Leblanc employing the "salt-cake." 2700 w. Min & Sci Pr—Dec. 29, 1900. No. 38529.

Leaching.

The Leaching of Copper Ores. J. Ohly. Suggestions and facts of value in working these deposits. 2100 w. Min & Sci Pr—Jan. 19, 1901. Serial. 1st part. No. 38868.

Mining.

Copper Mining in the United States. Waldon Fawcett. Historical review of the development of this industry, the progress and improvement of methods and facilities, briefly describing the equipment of the Calumet and Hecla mine, as an example of present practice. Ill. 1700 w. Am Mir—Jan. 24, 1901. No. 39025.

Production.

Copper in 1900. Estimates based upon the statistics collected by Mr. John Stanton, who receives the reports of all the large producing companies. Also a review of the copper market. 3500 w. Eng & Min Jour—Jan. 5, 1901. No. 38591.

GOLD AND SILVER.**Alluvial Mining.**

Deep Alluvial Mining. D. H. Browne. Practical hints. 3800 w. Aust Min Stand—Dec. 6, 1900. No. 38780 B.

Australia.

Gold Mining and Milling in Western Australia. A. G. Charleton. The first of a series of papers dealing with Western Australia. Treats of the history, position and general features of the districts. 4500 w. Engineering Magazine—Feb., 1901. No. 38980 B.

Chlorination.

The Chlorination of Gold Ores at Mount Morgan, Queensland. Ernest Willoughby Nardin. Abstract of a paper read before the Inst of Civ Eng in London. Describes the Hall-Richard process, which consists in subjecting the ore to the action of a solution of chlorine gas in water. 2200 w. Eng & Min Jour—Jan. 19, 1901. No. 38842.

Cripple Creek.

Cripple Creek. Arthur Lakes. Illustrated description of the volcanic formation and the present condition of the world's greatest gold-mining camp. 4800 w. Mines & Min—Jan., 1901. No. 38477 C.

Dredging.

Gold Dredging in California. Thomas J. Barbour. Abstract of a report made to the California State Miners' Asso. Reviews the work in dredging of various companies with a schedule as to what may be expected, showing the possibilities of gold dredging. 3000 w. Eng & Min Jour—Jan. 26, 1901. No. 39022.

Notes on Gold-Dredging in New Zealand. A. C. Perkins. Read at meeting of the N. S. W. Chamber of Mines. The early dredges used are described and the improvements noted; also the manner of working, and the cost per cu. yd. 2800 w. N Z Mines Rec—Nov. 16, 1900. No. 38767 B.

The Efficiency of Gold-Saving Appliances on Dredges. J. B. Smith. Discusses the losses and improvements needed, and the importance of a skillful winchman. 1000 w. N Z Miners Rec—Nov. 16, 1900. No. 38769 B.

Elevators.

Hydraulic Gravel Elevators. Illustrated description of a complete hydraulic gravel eliminating plant at the Cariboo Gold-fields, B. C. 900 w. Aust Min Stand—Nov. 22, 1900. No. 38467 B.

Georgia.

Gold Mining Developments in Georgia. Wilbur Colvin. Describes and illustrates what is at present the largest gold-mill of the Dahlonega gold belt. 2000 w. Eng & Min Jour—Jan. 26, 1901. No. 39021.

Gold.

The Metallurgy of Gold (La Metallurgie de l'Or). C. Grollet. A general review of the present state of the art, as shown at the Exposition of 1900. 3500 w. Revue Technique—Jan. 10, 1901. No. 38914 D.

Gold Mining.

Ralston Divide, Placer County, Cal. A. Bordeaux. Information regarding the work done in this gold-mining property during the last two years. Ill. 1600 w. Min & Sci Pr—Dec. 29, 1900. No. 38530.

The American Nettie. Arthur Lakes. An illustrated description of a mine furnishing an example of the peculiar cave deposits and the method of mining them, near Ouray, Colorado. 3000 w. Mines & Min—Jan., 1901. No. 38470 C.

Gravel Bars.

Gold in Snake River Gravel Bars. William H. Washburn. Reports investigations made from a point about 20 miles below Huntington, Ore., to 50 miles above Ontario. 1000 w. Min & Sci Pr—Dec. 29, 1900. No. 38531.

Ore Treatment.

Treating Non-Smelting Ores in South America. Describes the methods of treating silver ores in use in South America. 1400 w. Min & Sci Pr—Jan. 5, 1901. No. 38689.

Production.

Gold and Silver in 1900. A close estimate of the gold production of the world for the year 1900. Special reports of these metals from various districts are given. 10400 w. Eng & Min Jour—Jan. 5, 1901. No. 38592.

Rock-Scraper.

Ridland's Patent Pneumatic Rock-Scraper. J. A. Miller. Illustrated description of a machine designed for getting gold out of a hard crevassy rock. Its operation is also explained. 1200 w. N

Z Mines Rec—Nov. 16, 1900. No. 38768 B.

Silver District.

The Bora Creek Silver District, New South Wales. An account of this new district, which seems to be an important one, and of the development of the Conrad mine. 1100 w. Eng & Min Jour—Jan. 26, 1901. No. 39023.

Slimes.

The Agitation Process for Cyaniding Slimes. Charles S. Hurter. Describes a process whereby 80 per cent. of the total values of gold and silver in the slimes are recovered at a cost not exceeding \$1 a ton. Ill. 900 w. Eng & Min Jour—Jan. 19, 1901. No. 38841.

Stamp Milling.

Stamp Milling of Free Gold Ores. Dana Harmon. A discussion of the fundamental principles to be followed. Ill. 7000 w. Jour Assn of Engng Soc—Dec., 1900. No. 38821 C.

Victoria.

Mining at Moliagul (V.). Stanley B. Hunter. Information concerning the locality where the "welcome stranger" nugget was found—the largest and most valuable mass of gold yet unearthed in any part of the world. 1700 w. Aust Min Stand—Dec. 6, 1900. No. 38781 B.

IRON AND STEEL.

Armour Plates.

Armour-Plates at the Paris Exhibiton. M. Baclé. A general review of the exhibits. 2500 w. Engng—Jan. 18, 1901. Serial. 1st part. No. 39040 A.

Blast Furnaces.

A Century of Blast Furnace Practice. Walter Kennedy. A brief description of the three classes of furnaces used in the United States and the methods employed in each; also reviewing the Chinese system of producing iron, which is the most ancient practice known. Ill. 4000 w. Am Mfr—Jan. 3, 1901. No. 38579.

Canada.

The Development of Iron and Steel Industries in Eastern Canada. J. Steven Barrie. Read at the West of Scotland Iron & Steel Inst. An illustrated account of these industries, the ore deposits and manufacture. 5700 w. Ir & Coal Trds Rev—Jan. 18, 1901. No. 39050 A.

Germany.

The German Iron Industry in the Year 1900. Emile Schroder. A review of the production and trade. 2300 w. Ir & Coal Trds Rev—Jan. 11, 1901. No. 38804 A.

Iron Trade.

Some Controlling Features of the Iron and Steel Trade in 1900. Reviews the production, consumption, prices, and other

features. 2200 w. *Ir & Coal Trds Rev*—Dec. 28, 1900. No. 38614 A.

The Chicago Iron Trade in 1900. George W. Cope. A general review of conditions, prices, trade, etc. 5000 w. *Ir Age*—Jan. 3, 1901. No. 38488.

The English Engineering and Iron Trades. The annual review issued by Bolling & Lowe, of London. 3000 w. *Ir Age*—Jan. 3, 1901. No. 38490.

The Philadelphia Iron Trade. Thomas Hobson. Annual review of new plants and enlargements. 3400 w. *Ir Age*—Jan. 3, 1900. No. 38491.

The Pittsburgh Iron Trade in 1900. Robert W. Walker. Reviews the general features of the year, the labor troubles, new construction, foreign trade, etc., and the outlook. 13500 w. *Ir Age*—Jan. 3, 1901. No. 38489.

The Situation in the Iron Trade of Europe. J. Stephen Jeans. A review of the last year and a statement of the present condition of the trade, and the effect of American competition. *Ir Age*—Jan. 24, 1901. No. 38844.

Lake Superior.

First Half-Century of Lake Superior Ore Mining. Horace J. Stevens. Reviews the history of this region, the present condition and future outlook. 2800 w. *Am Mfr*—Jan. 3, 1901. No. 38580.

The Lake Iron Ore Industry. Dwight E. Woodbridge. Reviews the past year, and considers the outlook for the future. 4500 w. *Ir Age*—Jan. 3, 1900. No. 38493.

Open-Hearth.

On New Designs of Open-Hearth Furnaces for the Manufacture of Ingot Iron. R. M. Daelen and L. Pszezolka. Comments on various designs and investigates the merits of the Talbot process. 3300 w. *Ir & Coal Trds Rev*—Jan. 11, 1901. No. 38805 A.

Production.

Iron and Steel in 1900. Approximate estimate. 9200 w. *Eng & Min Jour*—Jan. 5, 1901. No. 38593.

Rails.

The McKenna Process of Renewing Old Steel Rails. An illustrated detailed description of a process which converts them into practically new rails of perfect section and of but slightly decreased weight. 3000 w. *Ir Age*—Jan. 17, 1901. No. 38752.

Slag.

Blast Furnace Slag for Fertilizing. Alexander D. Elbers. On the value of this material and the way of preparing it for use. 900 w. *Am Mfr*—Jan. 3, 1901. No. 38582.

Steel.

Development of Steel Manufacture in

the United States. Extract from article by Andrew Carnegie in the *N. Y. Evening Post*. 2000 w. *Ir Trd Rev*—Jan. 24, 1901. No. 38891.

The Effect of Annealing Upon the Physical Properties, and the Micro-structure of a Low Carbon Steel. Henry Fay and Stephen Badlam. An account of experimental investigations, with discussion of results. Ill. 0800 w. *Tech Quar*—Dec., 1900. No. 38770 E.

The Kernohan Steel Process. R. B. Kernohan. Illustrated description of a new method, intended to overcome some of the difficulties of the duplex process. 1800 w. *Ir Age*—Jan. 31, 1901. No. 39055.

Sweden.

The Swedish Iron and Steel, Metal, and Coal Industries. Report for the year 1899. 2200 w. *Engr, Lond*—Jan. 18, 1901. No. 39037 A.

Tin-Plate.

Review of the Tin-Plate Industry in 1900. Charles Lancaster. An interesting review of the present position of the trade, and the effect of American competition on British trade, giving detailed information of cost, production, etc. 4000 w. *Ir & Coal Trds Rev*—Jan. 11, 1901. No. 38806 A.

The Welsh Tin-Plate in 1900. Review of the year. 1900 w. *Col Guard*—Jan. 11, 1901. No. 38828 A.

MINING.

Address.

The Future of Mining. Nelson P. Hulst. Extract from an address delivered before the graduating class of the Michigan College of Mines, on the opportunities and future outlook for mining students. 5500 w. *Mines & Min*—Jan., 1901. No. 38471 C.

Concrete.

Use of Concrete in Mining. Marcel Habets. From a communication to the Soc. des Ing. de Liege. On its adaptability for lining shafts and drifts, and for making stoppings, illustrating the methods of putting it in place. 2200 w. *Mines & Min*—Jan., 1901. No. 38474 C.

Electric Power.

Electrical Apparatus in Coal Mining. John Price Jackson. A description of the most important machinery for electric locomotion, cutters and drills. 8000 w. *Jour Fr Inst*—Jan., 1901. No. 38657 D.

Notes on Electrical Development and Experience in the Cripple Creek District, Colorado. J. R. Cravath. An account of the uses to which electricity is applied, the companies supplying the power, etc. 4300 w. *Elec Wld & Engr*—Jan. 19, 1901. No. 38813.

Hoisting.

The Treatment of Flat Hoisting Cables. A. E. Johnson. Points that must receive attention to get good service from a flat rope in mine work. 1100 w. Min & Sci Pr—Jan. 12, 1901. No. 38759.

Igniter.

Firing Blasting Charges by Induction Sparks. J. von Lauer. Translated from *Oesterreichische Zeitschrift für Berg und Hüttenwesen*. Illustrated description of apparatus designed by the writer, and the results of experiments made. 1500 w. Col Guard—Dec. 28, 1900. No. 38610 A.

Induction Spark Igniter for Mining (Funkeninductions-Minenzündung). Johann von Lauer. Illustrating and describing a convenient form of igniter for mining explosives. 1800 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 15, 1900. No. 38951 B.

Mining Lamps.

Lamp-Testing Apparatus at the Johann Shaft, Karwin. L. Volf, in *Oesterreichische Zeitschrift für Berg und Hüttenwesen*. Illustrates and describes an apparatus so arranged that the lamps can be tested in vertical, up-hill and down-hill draughts. 2400 w. Col Guard—Jan. 11, 1901. No. 38829 A.

Lamp-Testing Apparatus at the Johann Mine at Karwin (Moravia). Showing the very complete arrangement of reservoirs and measuring devices in use for observing the behavior of safety lamps in the presence of mine gases. 3500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 5, 1901. No. 38954 B.

Philippines.

Mining in the Philippines. Information relating to the present condition of mining in the Islands, with notes on the deposits, the transportation facilities, materials needed, etc. 2600 w. Min & Sci Pr—Jan. 19, 1901. No. 38867.

Mining Machinery for the Philippines. On the demand for American machinery and equipments, with brief account of Spanish and native forms in use. 2200 w. Eng & Min Jour—Jan. 19, 1901. No. 38840.

Shaft-Sinking.

The Sinking of a Shaft at the Maria Mine, Near Aix-la-Chapelle, by the Freezing Process (Das Abteufen eines Schachtes Mittelst des Gefrierverfahrens auf Mariagrube bei Aachen). H. Stegemann. By the use of freezing apparatus a ventilating shaft 130 ft. was successfully sunk through sand. 2500 w. 1 plate. Glückauf—Jan. 5, 1901. No. 38956 B.

Strikes.

The Illinois Coal Operators' Plan for Removing the Occasion of Strikes. Her-

man Justi. How the plan originated and the method of accomplishing its object. 4000 w. Mines & Min—Jan., 1901. No. 38473 C.

Ventilation.

The Ventilation of Preliminary Workings in Gaseous Mines (Die Bewetterung der Vorrichtungsbetriebe in Schlagwetter-Gruben). F. Pospisil. A discussion of the paper of M. Petit, presented at the Mining Congress at Paris. Two articles. 4500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 5, 12, 1901. No. 38953 each B.

Winding.

Prevention of Overwinding at the Saint-Etienne Collieries, France. Illustrates and describes safety appliances in use and their operation. 1500 w. Col Guard—Jan. 11, 1901. No. 38825 A.

Weight of Winding-Drums for Deep Shafts. Daniel Burns. Discusses the mechanics of the question so far as it applies to the weight of the winding-drum. Ill. 1200 w. Trans Min Inst of Scotland—Vol. XXII., Part I. No. 38599 D.

MISCELLANY.**Aluminum.**

The Prospects of the Aluminum Industry. F. H. Leeds. Reviews the position of the aluminum trade, the method of winning it and the uses to which it is put, and how the industry is likely to develop. 3200 w. Elec Rev, Lond—Jan. 11, 1901. No. 38798 A.

Graphite.

Graphite. Malcolm McNaughton. Briefly describes the formation, occurrence, sources and amount of supply, and the various uses. 5000 w. Stevens Ind—Jan., 1901. No. 38886 D.

Nickel.

Nickel Industries of Canada. Information concerning the deposits, working, etc. 800 w. U. S. Cons. Repts, No. 932—Jan. 11, 1901. No. 38625 D.

Paris Exposition.

Some Metallurgical Features of the Paris Exposition. Joseph W. Richards. Describes briefly the minerals and metals shown in various forms by the different countries. 3000 w. Mines & Min—Jan., 1901. No. 38476 C.

Petroleum.

Petroleum in 1900. A review of the production. 1700 w. Eng & Min Jour—Jan. 5, 1901. No. 38595.

Submarine Oil Wells in California. W. G. Young. Brief account of the Summerland Field, where wells are sunk in the bed of the ocean. 1000 w. Eng & Min Jour—Jan. 12, 1901. No. 38685.

The New Texas Oil Fields. Illustrates the Lucas oil well, near Beaumont, Tex.

with an account of the recent discovery. 800 w. Eng & Min Jour—Jan. 26, 1901. No. 39019.

The Petroleum Industry of the Philippines. G. D. Rice. An account of the oil-producing regions, the deposits, manner of working, etc. 2800 w. Am Gas Lgt Jour—Jan. 21, 1901. No. 38823.

Production.

The Mineral and Metal Output of the United States in 1900. A preliminary

estimate of the production of the more important minerals and metals. 3800 w. Eng & Min Jour—Jan. 5, 1901. No. 38590.

Tin.

Sources of Tin Supply. Discusses the position of tin in the market, and the need of readjusting the balance. Reviews the principal supplies and conditions affecting the output. 1700 w. Engr, Lond—Jan. 4, 1901. No. 38737 A.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in November. Detailed list and classified summary. 4800 w. R R Gaz—Jan. 4, 1901. No. 38560.

Car Ferries.

American Car Ferries. Waldon Fawcett. Illustrations and information concerning the efficient car ferries on the Great Lakes. 1500 w. Sci Am—Jan. 19, 1901. No. 38758.

Deraillments.

Deraillments and Conclusions to Be Drawn Therefrom. W. H. Elliott. Condensed paper read before the Ry. Sig. Club, at Chicago. 2000 w. R R Gaz—Jan. 11, 1901. No. 38655.

Frictional Effect.

Frictional Effect of Railway Trains Upon the Air. Francis E. Nipper. Reports a series of experiments bearing on this subject. Ill. 2300 w. Ry & Engng Rev—Jan. 26, 1901. No. 39049.

High Speed.

Fast Runs. Tabulated statement of fast and unusual runs made during 1897-1900. 500 w. R R Gaz—Jan. 11, 1901. No. 38654.

The Question of the Cost of High-Speed Trains. C. Rous-Marten. Showing that the advantages of high speed cause it to be a profitable practice; rapid transportation being the counterpart to intensified production. 4500 w. Engineering Magazine—Feb., 1901. No. 38-979 B.

Long Run.

A Run from Adelaide to Sydney. Describes the train and run of 1,059 miles. 2700 w. Engr, Lond—Dec. 28, 1900. No. 38619 A.

Northern Pacific.

The First Time Card on the Northern Pacific. A facsimile of this interesting time card, with reminiscent notes concerning the early days on the Northern

Pacific, by George W. Cushing. 1800 w. Ry Mas Mech—Jan., 1901. No. 38637.

Supervision.

Some Ideas on Road Supervision. Eugene M'Auliffe. Discusses economics in the mechanical and operating departments. 2000 w. Loc Engng—Jan., 1901. No. 38526 C.

Telephones.

Telephone Train Despatching. On the adaptability of telephones to this work, precautions necessary, and the reason why so little used. 1300 w. R R Gaz—Jan. 4, 1901. No. 38559.

Train Service.

British and French Train Services in 1900. Charles Rous-Marten. Reviews the last year, the long runs, fast runs and general service in both countries. 4800 w. Engr, Lond—Jan. 11, 1901. No. 38808 A.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Repairs on Air Brakes on Box Cars. H. H. Harvey. Read at Chicago meeting of the Car Foremen's Assn. Describes methods of handling triple valve repairs in the most economical way. Ill. 2000 w. Ry Mas Mech—Jan., 1901. No. 38638.

Skipping Tests of Air Brakes. Richard A. Smart. Describes tests made to secure information as to the conditions under which the emergency feature of the quick action air-brake will skip cut-out cars. 900 w. R R Digest—Jan., 1901. No. 38773.

Bearings.

Middle Bearings on Driving Axles. N. Y., O. & W. Ry. Illustrates and describes the details of an adaptation devised by George W. West, to relieve the boxes at the sides of a portion of the weight. 450 w. Ry & Engng Rev—Jan. 19, 1901. No. 38849.

Buffers.

The Computation of Evolute Springs

(Die Berechnung der Evolutfeder). Victor Meyer. Developing formulæ and tables for use in proportioning evolute spiral springs such as are used for buffers for railway carriages. 2000 w. *Zeitschr d Ver Deutscher Ing*—Dec. 29, 1900. No. 38922 D.

Center Plates.

Center Plates. Edward Grafstrom. Considers the suggestions contained in the report of the committee of the M. C. B. Assn. Ill. 1500 w. *Am Engr & R R Jour*—Jan., 1901. No. 38513 C.

Equipment.

Four-Wheel Steel Frame Truck and Steel Frame Draft Gear. Drawings and description. 700 w. *Am Engr & R R Jour*—Jan., 1901. No. 38516 C.

Feed Water.

Water Softening Plant of the Cincinnati, Hamilton & Dayton Railway. Illustrated description of the plant with report of cost of operating. 900 w. *R R Gaz*—Jan. 4, 1901. No. 38558.

Fire-Boxes.

The Causes of Rapid Wear and Tear of Fire-Boxes of Locomotives. Robert Weatherburn. Discusses the causes of deterioration, and suggests ways of obviating some of the troubles. 4300 w. *Engr, Lond*—Dec. 28, 1900. No. 38617 A.

Fuel.

Oil as Locomotive Fuel in California. An account of the use of this fuel on the roads of California, and illustrated description of the oil-handling arrangements at Los Angeles. 1800 w. *Ry Age*—Dec. 28, 1900. No. 38494.

Gondola Car.

Low Drop-Bottom Gondola Car, 80,000 Lbs. Capacity. Illustrates and describes a design approved for adoption on the Chicago & Northwestern and allied lines. 300 w. *Am Engr & R R Jour*—Jan., 1901. No. 38515 C.

Locomotive Construction.

Locomotive Boilers Free From Strains (Der Spannungsfreie Lokomotivkessel). H. Lentz. A paper before the German Railway Society, discussing a form of suspension for locomotive boilers by which distorting strains may be avoided. Cast frames are also discussed. 3000 w. *Glaser's Annalen*—Jan. 15, 1901. No. 38935 D.

Locomotives.

European Express Locomotives. Frank C. Perkins. Illustrated descriptions of designs now in use on French, English and German railways. 1200 w. *R R Digest*—Jan., 1901. No. 38774.

German Express Locomotive with Auxiliary Driving Axle. Frank C. Perkins. Illustrated detailed description of a

recently constructed express locomotive exhibited at the Paris Exposition. 1500 w. *Sci Am*—Jan. 26, 1901. No. 38870.

German Locomotives at the Paris Exhibition. Illustrates and describes the exhibit of the Hanover Engine Construction Company. 800 w. *Engng*—Jan. 18, 1901. No. 39042 A.

Heavy Ten-Wheel Compound Passenger Locomotives with Wide Fire-Box—Lehigh Valley Railroad. An illustrated detailed description of an advanced design, with general dimensions, and inset. 1200 w. *R R Gaz*—Dec. 28, 1900. No. 38508.

New "Empire State Express" Locomotive. Brief illustrated description of an 8-wheel engine for fast service. 300 w. *Am Engr & R R Jour*—Jan., 1901. No. 38514 C.

Locomotives and Cars at the Exposition of 1900 (Die Weltausstellung in Paris, 1900. Lokomotiven und Wagen). E. Brückmann. A general review of the exhibits at Vincennes. Serial. Part I. 2000 w. *Zeitschr d Ver Deutscher Ing*—Dec. 15, 1900. No. 38915 D.

Locomotives at the Exposition of 1900 (Les Locomotives à l'Exposition de 1900). F. Barbier. An account of the Mallet system of compound articulated locomotives in connection with the exhibit of Maffei, of Munich. 2000 w. 1 plate. *Génie Civil*—Jan. 5, 1901. No. 38906 D.

Locomotives at the Paris Exposition, 1900 (Die Lokomotiven der Pariser Weltausstellung, 1900). S. Fraenkel. The beginning of an exhaustive review of the exhibits at Vincennes, with tabular view of the various engines, giving data as to dimensions and performance. Serial. Part I. 2000 w. 1 plate. *Glaser's Annalen*—Jan. 1, 1901. No. 38930 D.

Notes on the Locomotives Exhibited at Paris, 1900 (Quelques Observations Relatives aux Locomotives à l'Exposition de 1900). A general review of the exhibited engines, with regard to economy, design, and novelty. 3000 w. *Revue Technique*—Dec. 25, 1900. No. 38911 D.

Paris Exhibition.—Express Engine, Saxony State Railways. Illustrated detailed description. 1000 w. *Engr, Lond*—Jan. 18, 1901. Serial. 1st part. No. 39035 A.

Progress of Two-Cylinder Compound Locomotives During the Past Ten Years. C. J. Mellin. Reviews the progress in its evolution to the present state, and states its advantages over the simple engine. 3000 w. *R R Gaz*—Jan. 25, 1901. No. 38894.

Richmond Ten-Wheeler of Atlantic Coast Line. Illustration and dimensions. 300 w. *Loc Engng*—Jan., 1901. No. 38527 C.

Some Ten-Wheel Passenger Locomo-

tives—Atchison, Topeka & Santa Fe. Illustrated description of engines listed under the general head of Class B. 2000 w. R R Gaz—Jan. 18, 1901. No. 38778.

Ten-Wheel Passenger Locomotives—Atchison, Topeka & Santa Fe, Class B-15. Illustrated detailed description, with general specifications. 1500 w. R R Gaz—Jan. 25, 1901. No. 38892.

The Early Locomotives and Their Builders. Herman L. Morse. Describes the methods and appliances used by the builders of fifty years ago. 1700 w. Loc Engng—Jan., 1901. No. 38528 C.

The Paris Exhibition.—Express Engine with Auxiliary Driving Gear. An illustrated detailed description of this interesting engine with explanation of its operation. 1700 w. Engr, Lond—Jan. 4, 1901. No. 38736 A.

Vaughan Compound Consolidation Locomotives. Illustrated description of engines for the Union Pacific Ry. 400 w. Am Engr & R R Jour—Jan., 1901. No. 38517 C.

Wide Fire-Box, Atlantic Type, Locomotive—Baltimore & Ohio Railroad. Illustrations and general dimensions. 500 w. R R Gaz—Jan. 11, 1901. No. 38653.

Lubrication.

Effective Lubrication of Driving Boxes. Illustrates and describes methods in use, and thinks that in common practice too little motion is allowed. 1400 w. Am Engr & R R Jour—Jan., 1901. No. 38512 C.

Steel Cars.

Structural Steel Flat Car. Illustrated detailed description of specially designed very long cars. 1000 w. Ry & Engng Rev—Jan. 26, 1901. No. 39047.

The Design of Structural Steel Cars. George I. King. Gives standard specifications for freight car equipment of this type, calling attention to unusual features. Ill. 1700 w. R R Gaz—Jan. 4, 1901. No. 38557.

The Large Steel Car. W. S. Morris. Discusses its development and position in the business of railroads. 4000 w. Am Engr & R R Jour—Jan., 1901. No. 38511 C.

The L. M. Slack Steel Cars. Illustrated description of types of gondola cars recently designed. 1500 w. R R Gaz—Jan. 18, 1901. No. 38777.

Train Lighting.

See Electrical Engineering, Lighting.

Train Lighting from the Car Axle. Reviews the history of train lighting, from the beginning, when penny candles were used, and describes the Consolidation Axle Light system. Ill. 1400 w. Sci Am—Jan. 26, 1901. No. 38871.

Wheels.

Steel Wheels. Illustrates and describes

the manufacture of such wheels. 800 w. Am Mach—Jan. 3, 1901. Serial. 1st part. No. 38543.

NEW PROJECTS.

British Columbia.

Proposed Railroads in British Columbia. Concerning a proposed road to be known as the Victoria-Vancouver and Eastern Railway and Navigation Company. 700 w. U. S. Cons Repts, No. 940—Jan. 21, 1901. No. 38795 D.

Cuba.

Railroads in Cuba. Editorial on the importance of railroad facilities for the island, and discussion of the legal situation, and the plan in progress. 900 w. R R Gaz—Jan. 25, 1901. No. 38895.

Guatemala.

Guatemalan Railway Contract. Translation of a contract between the Government of Guatemala and the Central American Improvement Company, summarizing the principal articles. 900 w. U. S. Cons Repts, No. 940—Jan. 21, 1901. No. 38796 D.

Nicaragua.

Railway Contract in Nicaragua. Summary of the contract to construct a railroad from Managua to La Paz. 1000 w. U. S. Cons Repts, No. 928—Jan. 7, 1901. No. 38523 D.

Reconstruction.

The Reconstruction of the Utah Central Railway. W. P. Hardesty. An illustrated description of the newly constructed line between Salt Lake City and Park City at a cost of \$400,000. 3000 w. Eng News—Jan. 17, 1901. No. 38784.

PERMANENT WAY AND BUILDINGS.

Block System.

Length of American Railroads Worked by the Block System. A summary of miles of railroad in the United States worked by the block system. 3500 w. R R Gaz—Jan. 11, 1901. No. 38652.

Depot.

Tile Depot and Freight House, A. & W. R. R. Illustrated description of new building erected at Ashland, Ohio. 600 w. Ry & Engng Rev—Jan. 19, 1901. No. 38848.

France.

The Eastern Railway of France (Compagnie des Chemins de Fer de l'Est). An account of the permanent way exhibit of this road at Paris, including roadbed, rails, signals, etc., etc. 8000 w. 22 plates. Rev Gen des Chemins de Fer—Dec., 1900. No. 38942 H.

Freight Yards.

Method of Procedure in Remodeling Freight Yards. W. C. Cushing. A dis-

cussion of the general principles governing yard design and operation, illustrated by plans. 4500 w. R R Gaz—Jan. 4, 1901. No. 38556.

Greece.

Railway Construction in Greece. H. L. Geissel. Describes proposed extensions delayed by the South African War. 700 w. Eng News—Jan. 10, 1901. No. 38648.

Rails.

The Wear of Rails in Tunnels. Thomas Andrews. Read before the Inst. of Civ. Engrs. Reports results of an examination of a rail which had done service in such a situation, and discusses the subject generally. 3000 w. R R Gaz—Dec. 28, 1900. No. 38510.

Roundhouses.

A Modern Roundhouse. Illustrated detailed description of a thoroughly equipped roundhouse plant for the Chicago & Northwestern Ry., at Clinton, Ia. 1000 w. Am Engr & R R Jour—Jan., 1900. No. 38518 C.

Heating System of the Clinton, Ia., Roundhouse. Illustrated description of an admirable arrangement, and a statement of its advantages. 700 w. R R Gaz—Dec. 28, 1900. No. 38509.

Shops.

New Shops of the Wisconsin Central at Fond du Lac. General and detail plans of new repair shops, with illustrations and description. 1800 w. Ry & Eng Rev—Jan. 19, 1901. No. 38847.

Signaling.

A Description of the Present Method of Signaling Trains Through the St. Louis Tunnel. M. Wuerpel, Jr. Gives a short history of the traffic and earlier attempts at signaling, with illustrated detailed description of the system now in use. 5500 w. St. Louis Ry Club—Jan. 11, 1901. No. 39044.

STREET AND ELECTRIC TRAMWAYS

Berlin.

Electric Traction on the Berlin City and Belt Line (Der Elektrische Betrieb auf der Berliner Stadt und Ringbahn). D. Pforr. A comparison of electric with steam traction under similar conditions. 4000 w. Glaser's Annalen—Dec. 15, 1900. No. 38929 D.

Compressed Air.

The Compressed Air Motor in Street Car Service. A review of 28th and 29th sts. line in New York. An official statement of the running of the cars. 1900 w. Compressed Air—Jan., 1901. No. 38576.

Consolidations.

Consolidations of Street Railways. H.

A Simple Railway Signal System. E. C. Parham. Describes a signal system for use on single-track trolley roads. Ill 1200 w. Am Elect'n—Jan., 1901. No. 38632.

Automatic Block Signals on the Fort Wayne. Illustrates and describes the arrangement of signals from Allegheny City, Pa., to Homewood, on a busy suburban line. 3700 w. R R Gaz—Jan. 18, 1901. No. 38779.

Spring Plant.

The Pennsylvania Railroad's Spring Plant at Altoona. Illustrates several of the machines used, and gives description of their operation. 3500 w. R R Gaz—Jan. 25, 1901. No. 38893.

Station.

Great Central Railway.—Victoria Station, Nottingham. Illustrated description of a fine joint station. 1200 w. Engr, Lond—Jan. 18, 1901. Serial. 1st part. No. 39038 A.

Tunneling.

See Civil Engineering, Construction.

TRAFFIC.

Rebates.

Freight Rebates in England. Extract from the London Mail, concerning a rebate agreement by the Midland Ry. and the consequences. 700 w. U. S. Cons Repts, No. 938—Jan. 18, 1901. No. 38766 D.

Trans-Siberian.

The Trans-Siberian Railway (Le Chemin-de-Fer Trans-Sibérien). G. de Krivochapkin. Especially devoted to the economic influence of the railway upon the mineral industries of Siberia and upon international commerce. Two articles, 6000 w. Génie Civil—Dec. 15, 22, 1900. No. 38900 each D.

H. Vreeland. Discusses the benefits to the public and to employees, and gives interesting information. 1300 w. St Ry Rev—Jan. 15, 1901. No. 38850 C.

Development.

Development of Electric Traction. Frank B. Rae. Brief review from the first application of the magnetic motor to the propulsion of a car. 1600 w. W Elect'n—Jan. 5, 1901. No. 38663.

Economies.

Economies in the Installation of Electric Tramway Plant. W. H. Booth. Discusses things to be considered in designing a plant. 1900 w. Elec Rev, Lond—Jan. 18, 1901. No. 38897 A.

Electric Traction.

A Résumé of the Electric Street Railway. O. T. Crosby. Reviews the advantages and benefits to the public due to this enterprise. Ill. 3500 w. *St Ry Jour*—Jan. 5, 1901. No. 38585 D.

Electrolysis.

A Court Decision as to Responsibility for Damage by Electrolysis to Gas Mains. Gives a decision rendered at Indianapolis, Ind., that may prove of great importance. 1300 w. *Eng News*—Jan. 3, 1901. No. 38550.

Electrolysis. Albert B. Herrick. Gives the history of subterranean electrolysis, explaining the cause and effect, and means employed to reduce the trouble to a minimum. 2000 w. *St Ry Rev*—Jan. 15, 1901. No. 38854 C.

English Law.

Law of Deep Tunnel Railways. Discusses complaints made by occupiers of houses along the route, and the attitude of English law. 2400 w. *Engng*—Jan. 4, 1901. No. 38732 A.

Feeders.

The Supply of Current to Long Tramway Lines (Ueber Stromversorgung Längerer Bahnlinien). Dr. G. Rasch. A discussion of various feeder systems for tramway lines, including separate main stations, sub-stations, and alternating current supply. Two articles, 10000 w. *Elektrotech Zeitschr*—Dec. 20, 27, 1900. No. 38958 each B.

Future.

The Electric Railway of the Future—A Prophecy. Louis Bell. Reviews the general outlook for electric traction. 4000 w. *St Ry Jour*—Jan. 5, 1901. No. 38586 D.

The Future of the Electric Railway. B. A. Behrend and A. G. Wessling. A sketch containing many suggestions worthy of thought. 2500 w. *Elec Wld & Engr*—Jan. 12, 1901. No. 38683.

Generators.

Development of the Modern Railway Generator. Historical review, giving illustrations of many types. 4200 w. *St Ry Rev*—Jan. 15, 1901. No. 38853 C.

Heavy Service

Electric Traction for Heavy Railway Service. Edward P. Burch. Read before the Northwest Ry. Club. Shows the present standing of electric-railway engineering, and gives reasons why electric motive power will supplant the steam locomotive for heavy service. 5000 w. *St Ry Rev*—Jan. 15, 1901. No. 38855 C.

History.

Historical Notes of Electric Traction. Historical review, with introductory note by Frank J. Sprague. Portraits. 6000

w. *Elec Rev*, N. Y.—Jan. 12, 1901. No. 38715.

Improvements.

Electric Traction in the Twentieth Century. S. H. Short. Notes some of the agreeable changes due to the introduction of electric traction, and calls attention to improvements expected. 1500 w. *Elec Rev*, Lond.—Jan. 11, 1901. No. 38799 A.

Italy.

Electric Traction in Naples, Italy, and Vicinity. Information concerning the transformation of the horse-car lines and the system installed. 2200 w. *Elec Wld & Engr*—Jan. 19, 1901. No. 38814.

Manhattan Elevated Ry.

Electric Plant of the Manhattan Elevated Railway. An illustrated account of the main features of this installation. 4200 w. *Elec Wld & Engr*—Jan. 5, 1901. No. 38667.

The Electrical Equipment of the Manhattan Elevated Railway. A comprehensive series of articles relating to this great work in progress in New York. The magnitude of the work, the engineering problems, and special features introduced make the subject of great interest. This issue describes the generating station and distributing system in detail. Ill. 26200 w. *St. Ry Rev*—Jan. 5, 1901. No. 38584 D.

Multiple-Unit.

The Sprague Multiple-Unit Railway System. Edw. Chilton. Discusses the objections to the multiple-unit train system, and gives illustrated description of manner of controlling used in the Sprague system. 2200 w. *Am Elect'n*—Jan., 1901. No. 38634.

Narrow Gauge.

The Electric Narrow-Gauge Road in the Clausthal District (Die Elektrische Schmalspurbahn der Königlichen Berginspektion Clausthal). Dr. J. Werther. Describing a successful electric mining road in the Harz. 1200 w. *Stahl und Eisen*—Dec. 15, 1901. No. 38937 D.

Newfoundland.

The St. John's Street Railway. An illustrated description of interesting features of a road built where many topographical difficulties were encountered. 700 w. *St Ry Jour*—Jan. 5, 1901. No. 38587 D.

Power Plant.

Hydraulic and Steam Power Plant of the Virginia Electrical Railway and Development Company, Richmond, Va. Illustrated description of the new central station for supplying railway power and lighting current, and the elaborate hy-

draulic works in the James River rapids. 2400 w. Elec Rev, N. Y.—Jan. 26, 1901. No. 38876.

Power Station.

The Railway Power Station. Reviews the progress and development of the last ten years, and the various systems, and equipment. 4000 w. St Ry Rev—Jan. 15, 1901. No. 38852 C.

Progress.

Electric Tramways—Progress in the United Kingdom, 1891-1900. J. Clifton Robinson. A résumé of the history of tramways in Gt. Britain and Ireland during the last ten years. 5000 w. St Ry Rev—Jan. 15, 1901. No. 38851 C.

Railway Motors.

The Capacity and Rating of Railway Motors. Norman Wilson Storer. Gives a method for determining the capacity of railway motors and their fitness for any given service. 3500 w. St Ry Jour—Jan. 5, 1901. No. 38588 D.

Regulation.

The Regulation of Street Railway Motors (Ueber Regelung von Strassenbahnmotoren). K. Sieber. An examination of the various forms of controllers, with diagrams of their action. Elektrotech Zeitschr—Jan. 10, 1901. No. 38964 B.

Review.

Electric Traction and Transmission in the New Century. Philip Dawson. Gives a retrospect of the progress in England during the last 10 years, discusses the present position of the electrical indus-

tries, and the future outlook. 3500 w. Elec Rev, Lond—Jan. 4, 1901. No. 38700 A.

Southampton, Eng.

Southampton Corporation Electric Tramway and Lighting System. H. G. Nicholson. The electricity works were formerly for lighting purposes only, and how they have been adopted for supplying the necessary power for tramways is illustrated and described. 2400 w. Elect'n, Lond—Jan. 11, 1901. Serial. 1st part. No. 38845 A.

State Railway.

The Possibilities of a State Electric Freight Railway as a Substitute for a Barge Canal from Buffalo to the Hudson River. J. H. Ehrehart. A letter considering this subject. 1400 w. Eng News—Jan. 17, 1901. No. 38786.

Storage Batteries.

Influence of Storage Batteries Upon Railway Generating Apparatus. R. C. Hull. Showing how faithfully the storage battery can be made to perform its duty, and their use as applied to railway operation. 1600 w. Elec Rev, N. Y.—Jan. 19, 1901. No. 38782.

Tramways.

Tramways in Large Cities. C. H. Wordingham. Reviews the probable effects of the extensive network of tramways, destined to cover Gt. Britain, and some of the problems involved. 2700 w. Elec Rev, Lond—Jan. 18, 1901. No. 38896 A.

BINDING SECT. AUG 14 1967

TA
l
F25
v.20

Factory and industrial
management

Engin.

ENGIN STORAGE

PLEASE DO NOT REMOVE
CARDS OR SLIPS FROM THIS POCKET

UNIVERSITY OF TORONTO LIBRARY

